REPORT RESUMES

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AGRICULTURAL MACHINERY--POWER. TEACHERS COPY.

BY- VENABLE, BENNY MAC HILL, DURWIN
TEXAS A AND M UNIV., COLLEGE STATION
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THE PURPOSE OF THIS DOCUMENT IS TO PROVIDE A STUDY GUIDE FOR STUDENTS PREPARING FOR AGRICULTURAL MACHINERY OCCUPATIONS IN A VOCATIONAL AGRICULTURE COOPERATIVE EDUCATION PROGRAM. THE MATERIAL WAS DESIGNED BY SUBJECT MATTER SPECIALISTS ON THE BASIS OF STATE ADVISORY COMMITTEE RECOMMENDATIONS, TRIED IN OPERATIONAL PROGRAMS, AND REFINED BY A TEACHER. TOPICAL UNITS IN THE COURSE INCLUDE -- (1) INTRODUCTION, (2) INTERNAL COMBUSTION ENGINES, (3) LUBRICANTS AND LUBRICATING SYSTEMS, (4) FUEL SYSTEMS, (5) COOLING SYSTEMS, (6) ELECTRICAL SYSTEMS, AND (7) HYDRAULICS. UNIT MATERIALS INCLUDE INFORMATION SHEETS, ASSIGNMENT SHEETS, ASSIGNMENT ANSWER SHEETS, TOPIC TESTS, AND TOPIC TEST ANSWERS. THE MATERIAL IS SUITABLE FOR READING AND AS A GUIDE TO STUDY FOR STUDENTS WHO ARE EMPLOYED, MALE OR FEMALE, AND 16 TO 20 YEARS OLD. THE COURSE REQUIRES 175 PERIODS OF 50 MINUTES. OTHER TEXTBOOKS, BULLETINS, AND COMMERCIAL DATA ARE NECESSARY AND ARE SPECIFICALLY RECOMMENDED ON THE ASSIGNMENT SHEETS. THE DOCUMENT IS IN PRINTED AND LOOSELEAF FORM. THIS DOCUMENT IS AVAILABLE IN LIMITED NUMBERS FOR $4.00 EACH FROM AGRICULTURAL EDUCATION TEACHING MATERIALS CENTER, TEXAS AGRICULTURAL AND MECHANICAL UNIVERSITY, COLLEGE STATION, TEXAS 77843. (JM)

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Introduction

TOPIC: Orientation

OBJECTIVE: To develop an understanding of the importance of the retail agricultural machinery industry and study the organization and management of agricultural machinery dealership.

REFERENCES: Required:

1. Information Sheet

Supplemental:

2. Farm and Power Equipment Retailers Handbook, National Farm and Power Equipment Dealers Association, 2340 Hampton Avenue, St. Louis, Missouri 63139, pp. 1-7.

QUESTIONS or ACTIVITIES:

1. What does a machinery dealer expect of his employees?
2. How has agricultural machinery dealers been of assistance to farmers?
3. Has the decrease in the number of farm workers resulted in a decrease in production?
4. Fifty years ago one farmer could produce food and fiber for six other persons. What can that same farmer do today?
5. How has farm machinery help raise the standard of living of the farmer?

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Information Sheet
on
ORIENTATION

A person planning to work in the service occupations of an agricultural machinery dealership must understand the organization and management of the dealership if he is to be effective as a service employee. He must understand (1) the importance of the local dealership and the agricultural machinery industry to the agricultural industry of the community, nation, and world, (2) the relationship of the local dealership to the farmer and the parent organization, (3) the ways the local dealership carries out its business, (4) the jobs and job functions of employees in the local dealership, and (5) show the relationship of farming to merchandise handled by the dealership. A local agricultural machinery dealer expects his employees to be able to do their jobs with a high degree of speed and efficiency. In order to meet these expectations, the employees must have a thorough knowledge of the complete operation of the business.

Agricultural machinery dealers have played a vital role in the social and economic life of those engaged in production agriculture as well as the standard of living of all people.

1. They have provided the farmer with efficient and economic production tools.

2. Modern agricultural machinery has lowered the costs of production for the farmer. The following table bears out this fact.

Farm Output and Labor and Machinery Inputs
Index 1947-49 = 100

(Indices)

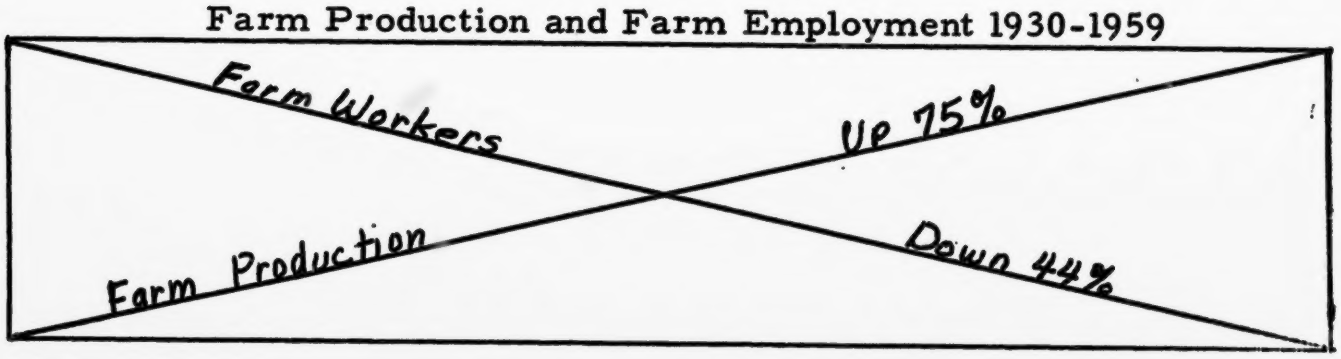
Year	Farm Output	Farm Labor	Power and Machinery	Labor Plus Machinery	Relation of Combined Labor and Machinery Inputs to Output
1910	61	135	28	163	133
1920	70	143	44	187	133
1930	72	137	55	192	133
1940	82	122	58	180	110
1950	101	90	118	208	103
1955	113	76	136	212	94
1956	114	72	137	209	92
1957	114	68	138	206	93
1958	124	66	137	203	84
1959	126	64	139	203	81

Orientation
(Information Sheet continued)

The use of agricultural machinery has promoted an increase in farm production and income in spite of a decrease in the number of persons employed on the farm.

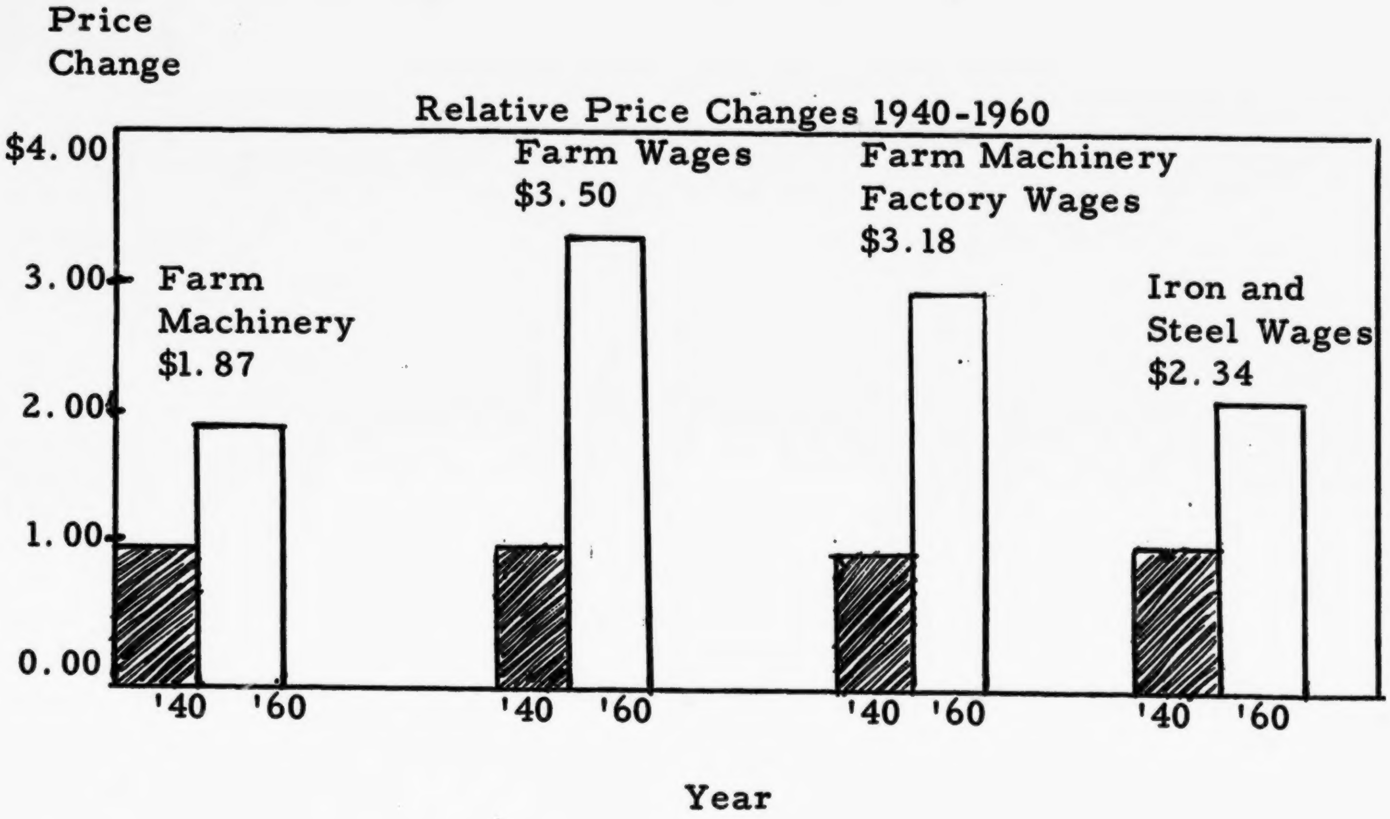
1. While farm workers have decreased in number, farm production has increased.

Farm Production and Farm Employment 1930-1959



2. The agricultural machinery industry has managed to keep its price rise on production costs relatively low.

Relative Price Changes 1940-1960



3. Fifty years ago one farmer could produce food and fiber for six other persons, whereas today, that same man can produce food and fiber for at least 29 others.

4. Today, 40 percent of the farms produce 87 per cent of the food and fiber sold from the farms.

The use of modern agricultural machinery has aided in raising the standard of living of the farmers.

1. Today farmers have more time for recreation, more conveniences, better educational advantages and improved facilities.
2. The investment in agricultural machinery is highest on farms in states having the highest standard of living.
3. The development and use of labor saving machines have made it possible for millions of farm workers to enter other industries, the arts, sciences, and professions.

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Materials for this Information Sheet was taken from Organization and Management of Machinery Dealerships, The Center for Research and Leadership Development in Vocational and Technical Education, The Ohio State University, 1965

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Introduction

TOPIC: Orientation

OBJECTIVES: To understand the methods of distributing agricultural machinery.

REFERENCES: Required:

1. Information Sheet, "Orientation"

Supplemental:

2. Farm and Power Equipment Retailers Handbook
NFPED Association, pp. 7-21

QUESTIONS or ACTIVITIES:

1. How does agricultural machinery get from the manufacturer to the farmer?
2. Who designs new machines?
3. How are parts supplied to the dealer?
4. Who sells agricultural machinery to the farmer?
5. Who is responsible for storage of the equipment?

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Information Sheet
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ORIENTATION

The distribution of agricultural machinery follows this route: from manufacturer-to branch house - to dealers - to customers. All orders for machines by the local dealership are placed with the branch house.

The above pattern of distribution accounts for practically the entire output of domestic sales of tractors and other agricultural machinery.

The primary function of the manufacturer is to supply the agricultural machinery needed by the agricultural industry.

1. Manufacturers employ competent product engineers to design the new machines needed by the agricultural industry.
2. Manufacturers supply the branch houses with the parts and some machines to supply their dealers.

In addition to performing these functions, the manufacturer does the following:

1. Keeps in touch with machinery problems and needs of farmers
2. Through research, develops machines and systems to meet the needs of the farmer

The function of the branch house is to move the machinery from the factories to the farms in the most economical manner.

1. The branch house provides storage for the manufacturer.
2. The task of sales and distribution for the manufacturer is undertaken by the branch house.
3. Through this medium, the manufacturer gets national distribution more quickly and more thoroughly.
4. Retail dealers get more prompt and reliable service.
5. As the manufacturer's distributive agent, the branch house keeps the manufacturer advised on market conditions and needs of a particular area.

Orientation
(Information Sheet continued)

6. The branch office lowers substantially the manufacturer's handling cost of agricultural machinery and ultimately the farmers' purchasing costs.

7. The branch house buys parts in large quantities, relieving the manufacturers of the details of selling, warehousing, shipping of merchandise to individual dealers, and carrying of dealer accounts.

8. The branch house carries adequate stocks of repair parts at strategic locations, resulting in better service to the dealer, and thus the customer.

The distributor (branch house) builds a good dealer's organization and confines all his efforts to selling through dealers.

1. The distributors organization includes a service department with personnel who thoroughly understand the servicing of each machine handled.

2. A well developed program of selling is maintained by the distributor who aids the dealer in realizing a greater profit through better service to the customer.

The local agricultural machinery dealer is the vital link in this distribution pattern.

1. The dealer is the final link between the manufacturer and the user of the machine.

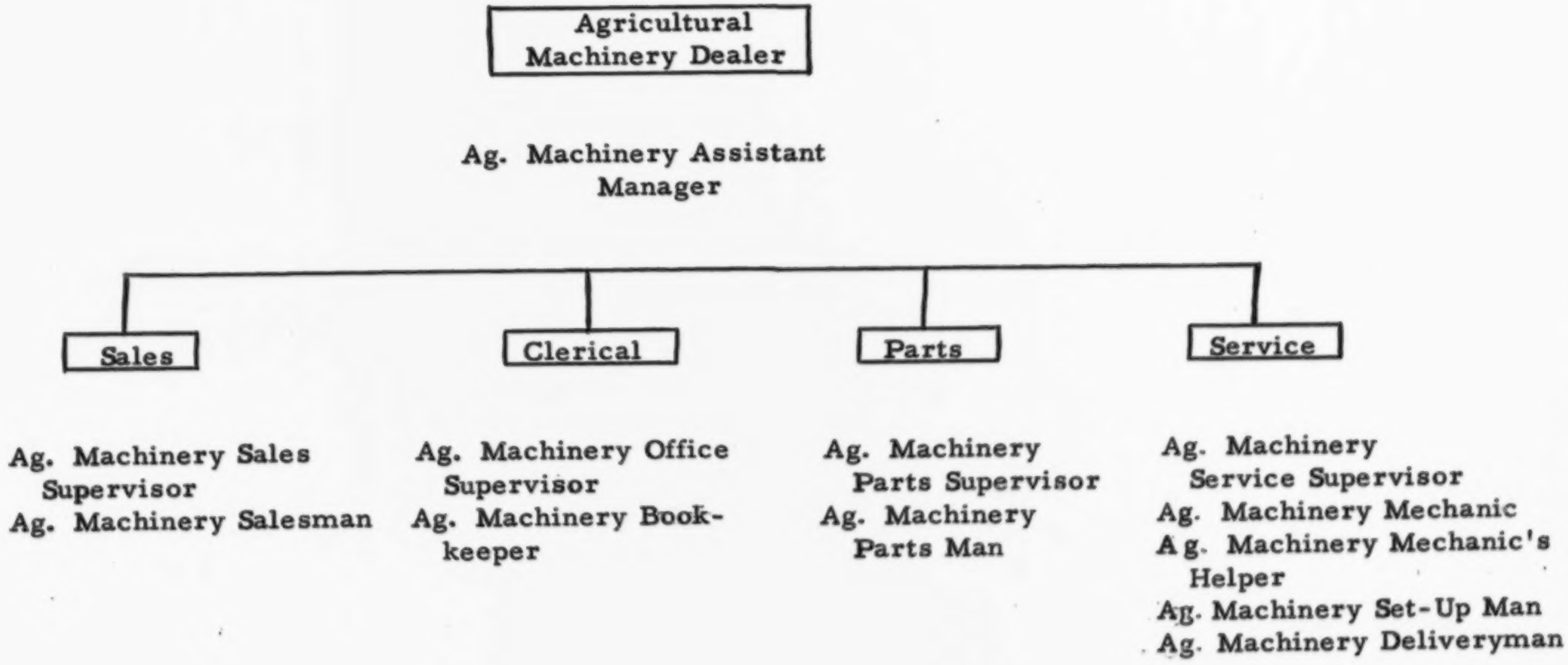
2. The dealer contributes greatly to the farmer's knowledge of machinery servicing.

3. He demonstrates the efficiency of the company machines to the farmer and explains how the machine can benefit the farmer.

4. He extends credit in many cases to the farmer so the machine can pay for itself in labor saved or money earned.

5. The dealer makes an effort to understand farm machinery problems and the need of the farmer and conveys these needs back to the manufacturer to provide a basis for improvement of farm machines through research.

Organizational Structure of a Local Agricultural Machinery Dealership



Agricultural Machinery Dealer

Ag. Machinery Assistant Manager

Sales

- Ag. Machinery Sales Supervisor
- Ag. Machinery Salesman

Clerical

- Ag. Machinery Office Supervisor
- Ag. Machinery Bookkeeper

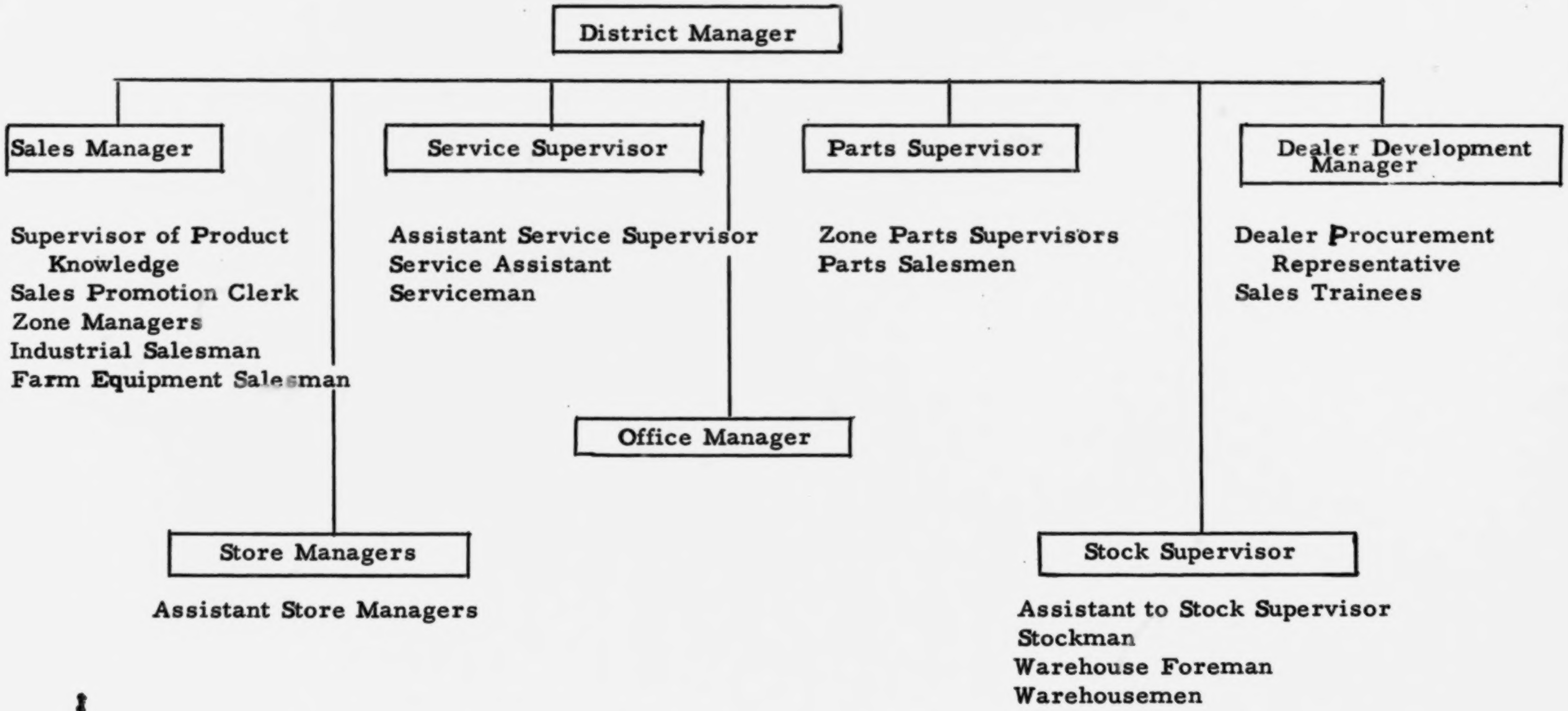
Parts

- Ag. Machinery Parts Supervisor
- Ag. Machinery Parts Man

Service

- Ag. Machinery Service Supervisor
- Ag. Machinery Mechanic
- Ag. Machinery Mechanic's Helper
- Ag. Machinery Set-Up Man
- Ag. Machinery Deliveryman

An Example of the Organizational Structure of a Major Line Agricultural Machinery Branch House


District Manager
Sales Manager
Supervisor of Product Knowledge
Sales Promotion Clerk
Zone Managers
Industrial Salesman
Farm Equipment Salesman
Store Managers
Assistant Store Managers
Service Supervisor
Assistant Service Supervisor
Service Assistant
Serviceman
Office Manager
Parts Supervisor
Zone Parts Supervisors
Parts Salesmen
Stock Supervisor
Assistant to Stock Supervisor
Stockman
Warehouse Foreman
Warehousemen
Dealer Development Manager
Dealer Procurement Representative
Sales Trainees

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Assignment Sheet
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AGRICULTURAL MACHINERY MECHANICS

UNIT: Introduction

TOPIC: General Shop Safety

OBJECTIVE: To develop an understanding of the importance of developing proper safety habits.

REFERENCES: Required:

1. Information Sheet, "General Shop Safety"

Supplemental:

2. Automotive Mechanics, Crouse, pp. 29-30and 425
3. Automechanics, Glenn, Chapter 18

QUESTIONS or ACTIVITIES:

1. Why is the proper attitude so important in the shop?
2. Why is visiting a bad practice in the shop?
3. Why should you avoid horse play in the shop?
4. What should you do after handling acids or batteries?
5. How should heavy objects be lifted?

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910-I-2a

Information Sheet
on
GENERAL SAFETY PRACTICES

The practice of safety in the shop goes beyond the knowledge of the proper use of hand tools and equipment. A most important consideration is your attitude. You must understand the hazards of the job you are about to undertake and must appreciate the need for applying such safety practices that will protect you from injury. Awareness of personal safety comes only through an understanding of the dangers which are present. Most accidents are caused by thoughtlessness, so you must be on guard at all times.

It is most important to give the job your undivided attention. "Visiting" is not permitted because it distracts you and may lead to an accident.

Horseplay, scuffling, punching, or playing pranks is dangerous. Some boys cannot pass by without striking a classmate, and the immediate response is to strike back. In no time at all both boys are scuffling. This childish action may result in a fall or possible injury from sharp tools, steel benches, and heavy equipment which are always present in a shop. Keep such physical activity for the athletic field where it is an approved activity.

Walk-avoid running! A running person cannot always keep from slipping with the possibility of serious injury. Bumping the operator of a machine might cause him to have an accident which would be your fault. Cultivate personal caution at all times. A cautious person is one who knows and observes safe procedures. Learn that caution and foresight pay off. A person who has learned to cultivate personal caution has trained himself to visualize the results of his actions.

Make it a habit to remove any article lying on the floor before someone trips over it. Learn to recognize unsafe conditions. In doing so you are protecting yourself and fellow workers. Get into the habit of removing sharp pointed tools from bench edges where you, or someone else going by, may get hurt-this is an application of personal caution. Store sharp-edged tools in racks and not in drawers where someone could cut himself when picking up other implements.

A protruding nail is an invitation to a first-aid station; either hammer it down or pull it out. Remove any splinters from boxes or pieces of wood which could puncture your skin.

Scraps of sharp metal on the floor could pierce someone's shoe, causing a serious wound-pick them up and place them in the scrap box.

General Safety Practices
(Information Sheet continued)

Wipe spilled oil or grease off the floor-even though you did not spill it. Preventable falls send far too many people to the hospital.

Report any injury to your instructor immediately. No matter how small the injury-report it! It is far better to waste antiseptic than to ignore one small wound.

If something gets into your eye, it is dangerous to rub it. Instead report to your instructor immediately.

Be sure to wash your hands after handling caustics, acids, or batteries to avoid getting chemicals on your skin and into your eyes.

Asking for help when lifting a heavy object is a sign of mental strength, not weakness. Many serious injuries are caused by lifting improperly, lifting objects too heavy for one man, or lifting unwieldy shapes. More than 25% of all disabilities are caused by the improper handling of materials. This is the largest single cause of disability from all accidents. Sprains, strains, and hernias-the results of improper lifting-are painful and disabling.

When lifting a heavy object, place your feet close to the object for proper balance. Keep your elbows as straight as possible and bend the knees while gripping. Use your large leg muscles to lift-not the back muscles. Keep your back straight. When lifting a heavy object with the help of others, be sure that a signal is given by one of the team so that excess strain is not placed on any one member of the group. Teamwork accomplishes much more than individual effort.

Carry all objects in such a manner that you can see clearly where you are going. Long objects should be carried by two people to protect others.

Power tools are provided with guards to prevent accidents. They are placed there for your protection. Be sure to call the instructor's attention to any loose or missing guard.

Wearing the proper clothing is very important when working in the shop. Each shop requires a specialized protective garment depending on the nature of the work. Some shopwork demands additional temporary protection when doing special jobs. This may take the form of goggles and gloves when welding; goggles or face shield for grinding; or a rubber mat when working around live electrical circuits.

Gloves should be worn when handling hot objects, especially when welding.

General Safety Practices
(Information Sheet continued)

The hand tool is still very important, despite the development of complex machine tools. Everyone has need for hand tools, but not everyone knows how to use or care for them properly. A recent study of shop accidents showed that 66% of all injuries in one year were caused by misuse of the common hand tool. Most hand tool accidents are caused by (1) improper storage, (2) failure to keep the tool in good condition, (3) using the tool improperly, and (4) failure to use the right tool for the job.

Hand tools should be stored in a tool rack which has a place for each tool; they should not be stored in drawers or boxes. Tools should be cleaned frequently and stored in a dry place to prevent rusting. A light coating of oil will keep them bright under adverse conditions.

Wrenches are designed to be inserted from the side of a nut (as in the case of an open-end, adjustable, monkey, or pipe wrench), or over the top (socket or box wrench) to hold it firmly for removing or tightening.

If you have to pull hard on a wrench, make sure that it seats squarely or it may slip. Pushing on a wrench is dangerous; if the nut breaks loose suddenly you may skin your knuckles, However, if you do have to push on the wrench, use the palm of your hand.

Whenever you do have to exert any real force, there are two important points to remember: (1) Always place the wrench on the nut so that the pulling force is applied to the strong, stationary side of the handle, as it can withstand the greatest stress. (2) After placing the wrench on the nut, tighten the adjusting knurl so that the jaws fit the nut securely, to prevent slipping.

Hammering on a wrench or extending it with a pipe places an excessive strain on a wrench which it is not designed to take.

When chipping, always wear goggles to protect your eyes. If others are working close by, make sure they are protected from flying chips by a screen, or else chip in a direction which is clear of workers. Remember- the time to take precautions is before you start a job, not after someone is injured.

It is dangerous to use a file without a handle, as the end of the tang is quite sharp. If the file "hangs up" by catching on the work, your hand might jam against the end of the tang, resulting in a very painful puncture wound.

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Material for this Information Sheet was taken from AUTOMECHANICS by Harold T. Glenn

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Introduction

TOPIC: Orientation

OBJECTIVE: To understand the jobs and job functions in the organization of the local agricultural machinery dealership.

REFERENCES: Required:

1. Information Sheet

Supplemental:

2. Farm and Power Equipment Retailers Handbook, 2340 Hampton Ave., St. Louis, Missouri, 63139, pp. 74-76;251-256.

QUESTIONS or ACTIVITIES:

1. What are the five areas the local dealership operation is divided into?
2. What are the duties of management?
3. What are the duties of a salesman?
4. What are the duties of the parts man?
5. What are the duties of the mechanic?
6. What are the duties of a set-up and delivery man?

b. Salesman

Finds prospective buyers
Conducts demonstrations
Appraises used machinery
Closes sales
Makes financial arrangements for customer to purchase machinery
Maintains sales room
Follows up past sales

3. Clerical

a. Office Supervisor

Directs record keeping
Directs office procedures
Directs collections
Directs payments
Checks financial standing of potential customers

b. Bookkeeper

Posts books
Directs depository funds
Writes orders and letters
Prepares payroll
Writes contracts
Assists in closing books

4. Parts

a. Parts Supervisor

Directs ordering and selling of parts
Selects parts employees
Trains parts employees
Maintains inventory control
Maintains catalogues and price lists
Plans merchandising programs

b. Parts Man

Dispenses shop parts
Dispenses customer parts

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Information Sheet
on
ORIENTATION

The operation of the agricultural machinery dealership is divided into five areas.

1. Management

2. Sales

3. Clerical

4. Parts

5. Service

The nature of the work carried out in each area is determined by its function in the operation of the total business.

People in each area are employed with specific responsibilities.

1. Management

    Determine company policies
    Exercise financial control over the business
    Select, train and supervise employees
    Forecast and plan future company business
    Direct customer and employee relations
    Promote sales
    Coordinate jobs

2. Sales

    a. Sales Supervisor

        Directs sales work
        Directs sales records
        Promotes sales
        Trains sales employees
        Assists in job coordination

Maintains parts inventories
Checks inventories
Maintains price catalogue
Constructs displays
Maintains parts identification

5. Service

    a. Service Supervisor

    Directs personnel
    Selects and trains personnel
    Maintains service records
    Advises on service problems
    Inspects repair jobs
    Directs machinery storage
    Schedules machinery assembly
    Prepares delivery orders
    Directs delivery

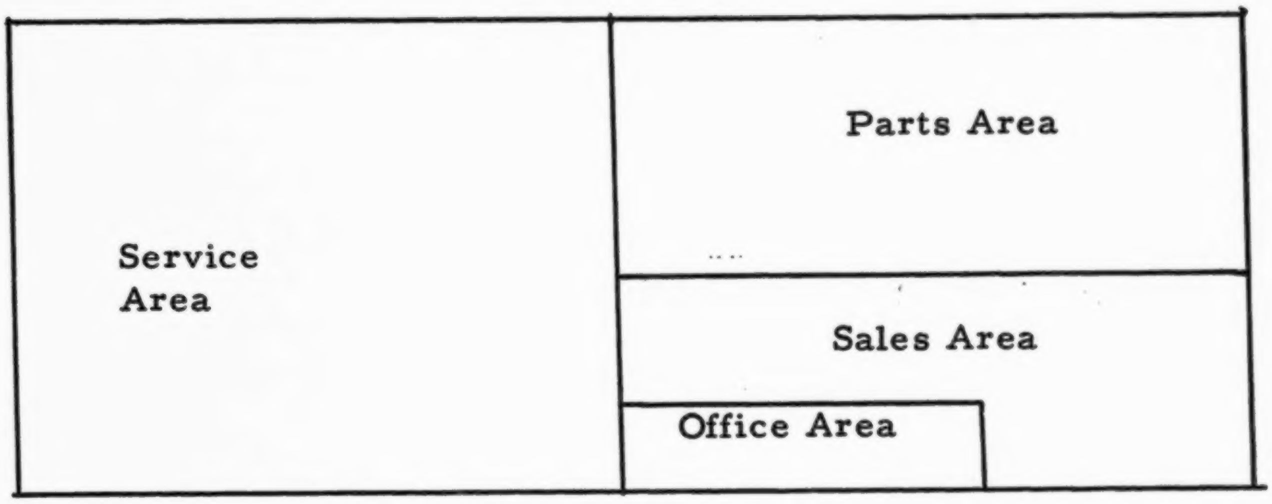
    b. Mechanic

    Makes general repairs
    Handles field repairs
    Conducts special operations
    Reconditions trade-ins
    Makes pre-delivery checks
    Maintains demonstration units
    Services rolling stock
    Maintains shop equipment

    c. Set-up and Deliveryman

    Picks up and receives new machinery
    Assembles new machinery
    Delivers and starts machinery

These areas have well-defined limits in which to operate in the dealership.


Parts Area
Service Area
Sales Area
Office Area

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Material for this Information Sheet was taken from the Organization and Management Dealerships, The Center for Research and Leadership Development in Vocational and Technical Education, The Ohio State University, 1965

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910-I-4a

Assignment Sheet
for
INTRODUCTION

UNIT: Introduction

TOPIC: Hand-Tools-Identification and Use of Metals and Layout Tools

OBJECTIVE: To develop an understanding of how to detect certain metals and to properly use layout tools.

INTRODUCTION: Farming is becoming more merchandised each year. With increased use of mechanized comes a need for a greater number of repair jobs. Many simple jobs, such as removing broken bolts, threading, tapping, and reinforcing are cold metal jobs. These tasks become easier as one learns to properly use the tools at his disposal.

REFERENCE: Required:

The Farm Shop, T. J. Wakeman, pp. 83-88

QUESTIONS or ACTIVITIES:

1. What two factors determine the amount of carbon the structural arrangement of metals?
2. What is the name given to the heating and cooling process by which cast iron is made soft, strong, and mallable?
3. How will the sparks look when a high carbon steel is placed on a grinder?
4. What size combination square blade is most suitable for general work?
5. What is the purpose of a scratch awl?

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910-1-4b

Assignment Sheet
for
INTRODICTION

UNIT: Introduction

TOPIC: Hand Tools-Cutting Cold Metal

OBJECTIVE: To develop an understanding of how to select proper tools for cutting cold metal and to become aware of the correct methods involved.

INTRODUCTION: The need for cutting cold metal in a farm shop arises quite often. Much valuable time and effort can be saved by learning the proper tools to use and by developing skills in the methods of cutting metal.

REFERENCES: Required:

The Farm Shop, T. J. Wakesman, pp. 88-92

QUESTIONS or ACTIVITIES:

1. Why are soft-back blades more widely used than the hard-back hacksaw blades?
2. What are the four standard shapes for cold chisel cutting edges?
3. What procedure should be used when cutting round stock with cold cutters?
4. What two types of metal should be cut with bolt cutters?
5. Why are cold chisels tempered?

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910-I-4c

Assignment Sheet
for
INTRODUCTION

UNIT: Introduction

TOPIC: Hand Tools-Shaping Stock and Filing

OBJECTIVE: To develop an understanding of the methods used in shaping stock and to learn different types of files and their use.

INTRODUCTION: The skills of shaping stock and filing metal are needed frequently in the farm shop. There are several fundamental principles of which one should be aware before bending stock.

REFERENCES: Required:

The Farm Shop, J. T. Wakeman, pp. 93-96

QUESTIONS or ACTIVITIES:

1. How do sharp corner bends affect metal?
2. What are the two tools needed to twist cold metal?
3. What type of metal is used to make files?
4. List the six parts of a file.
5. What should be done to prevent the tang from being a hazard?
6. List the eight types of files.

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Assignment Sheet
for
INTRODUCTION

UNIT: Introduction

TOPIC: Hand Tools-Drilling

OBJECTIVE: To develop an understanding of the tools and techniques used in drilling metal.

INTRODUCTION: Several different drilling machines can be used for drilling cold metal: the power drill press, the post drill, the drilling post ("Old Man") and a hand ratchet, the electric portable drill, and the breast drill.

REFERENCES: Required:

The Farm Shop, T. J. Wakeman, pp. 96-101

QUESTIONS or ACTIVITIES:

1. What is the most widely used drilling machine in cold metal work?
2. What number of twist drill is smallest?
3. At what size do fractional size drills start?
4. Why must metal be clamped tightly to the drill press table before drilling?
5. What type of vise is used to hold round stock?

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Assignment Sheet
for
INTRODUCTION

UNIT: Introduction

TOPIC: Hand Tools-Tapping and Threading

OBJECTIVE: To develop an understanding of tapping and threading techniques.

INTRODUCTION: A beginner in a farm shop usually does not work long before he runs into the problems of tapping and threading. These tasks are relatively simple if the proper techniques are observed.

REFERENCE: Required:

The Farm Shop, T. J. Wakeman, pp. 101-105

QUESTIONS or ACTIVITIES:

1. What are the two common types of bolt and nut threads?
2. What type of thread is used in tractor engines?
3. What are the three types of taps?
4. What are the three common types of dies?
5. What is a screw plate?

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Introduction

TOPIC: The Parts of Machines

OBJECTIVE: To learn proper identification of parts of farm equipment that are essential in the construction of a workable machine.

INTRODUCTION: The component parts of farm equipment include those parts that are essential to construct a complete high-quality operative machine.

REFERENCES: Required:

1. Farm Machinery and Equipment, Smith, Ch. 5
2. Ball & Roller Bearings, American Association of Agricultural Engineering and Vocational Agriculture.

Supplemental:

3. Tractors and Crawlers, Frazee-Bedell, pp. 64-85.

QUESTIONS or ACTIVITIES:

1. Explain the function and application of a cam.
2. Define and explain the difference between an anti-friction and friction bearing.
3. What is the function of a bearing?
4. What are the types of ball bearings?
5. What are the types of roller bearings?

UNIT: Introduction
TOPIC: The Parts of Machines
(Assignment Sheet continued)

6. How do roller bearings differ from ball bearings?
7. How would a person determine the proper bearing to use?
8. Explain why a bearing must be properly lubricated.
9. Where are tapered roller bearings used?
10. What kind of bearings need bushings?

VOCABULARY: The following key words or terms have been used in this assignment and should now be a part of your vocabulary. Explain or define each:

Intermittent
Axial
Carburizing
Case harden
Creep
Crowned
Deflection
End play
End shake
Heat treatment
Loading grooves
Radial load

Load line
Load line angle
Misalignment
Preload
Press fit
Push fit
Raceway
Radial
Radial clearance
Separable
Spherical
Thrust load

910-I-6b

Agricultural Education
Teaching Materials Center
College Station, Texas
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Texas Education Agency
Texas A&M University
(cooperating)

Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Introduction

TOPIC: The Parts of Machines

OBJECTIVE: To develop an understanding of types of fasteners, washers, snap rings, and springs used in farm machinery.

INTRODUCTION: In every trade or occupation the problem of properly fastening parts of objects together is extremely important. At one time in history the supply of common nails, bolts, and bailing wire was sufficient. Today this is no longer the case. Today's mechanic must be familiar with names, sizes, uses, and standards of the most commonly used fasteners.

In this assignment we will discuss and illustrate some kinds, sizes and types of common fasteners so that you may familiarize yourself with them.

It is felt that this is most necessary because of the complex, high speed and precision world in which we live, and the safety conscience employees and employers of today's industry.

REFERENCES: Required:

1. Information Sheet, "Fastening Devices"

2. Farm Machinery and Equipment, Smith, pp. 50-54.

Supplemental:

3. The Farm Shop, Wakeman & McCoy, pp. 105-106.

UNIT: Introduction
TOPIC: The Parts of Machines
(Assignment Sheet continued)

QUESTIONS or ACTIVITIES:

I: Place in the blanks in the margin the number of the answer which you think makes a correct statement of the following:

1. ____ The pitch of a screw is (1) the number of threads on the screw; (2) the distance between threads; (3) the angle between thread faces; (4) the diameter of the threads; (5) none of these.

2. ____ The proper device for determining the pitch of a given screw is (1) micrometer; (2) rule; (3) calipers; (4) pitch gauge; (5) none of these.

3. ____ Most of the new-type fasteners now on the market came from (1) the aircraft industry; (2) confiscated German patents; (3) the building trades; (4) the shipbuilding industry.

4. ____ Hexagon socket-head screws are also known as (1) Phillips head; (2) clutch head; (3) cross head; (4) slotted head; (5) none of these.

5. ____ The chief advantage of the spline and clutch head screws is the fact that they are (1) neat in appearance; (2) easy to withdraw; (3) safer; (4) able to absorb more turning force; (5) none of these.

6. ____ To find the length of flat head wood screws, one measures (1) overall length; (2) from bottom of slot to point; (3) the shank; (4) none of these.

UNIT: Introduction
TOPIC: The Parts of Machines
(Assignment Sheet continued)

7. ____ Self-tapping screws are used extensively in sheet metal chiefly because (1) they have a better appearance; (2) they are stronger than other fasteners; (3) they are easily installed; (4) they do not require washers; (5) none of these.

8. ____ A flat head cap screw 1/4 inch in diameter and 1 1/2 inches long with coarse series threads will usually be described:
(1) 1/4" Cap Screw 1 1/2-20NC-FLT. HD.
(2) 1/4" x 1 1/2"-20NC-FLT. HD. Cap Screw
(3) 1/4" FLT. HD. Cap Scres 1 1/2"-20NC.

9. ____ Rivets are not practical for use in fastening metal parts which (1) require considerable strength; (2) must be assembled accurately; (3) will be removed or replaced periodically; (4) are subjected to vibration; (5) none of these.

FASTENING DEVICES

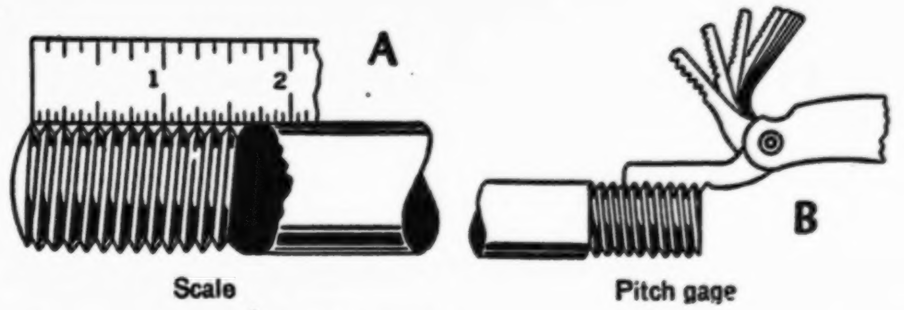

A
1
2
B
Scale
Pitch gage

Figure I. MEASURING SCREW PITCH

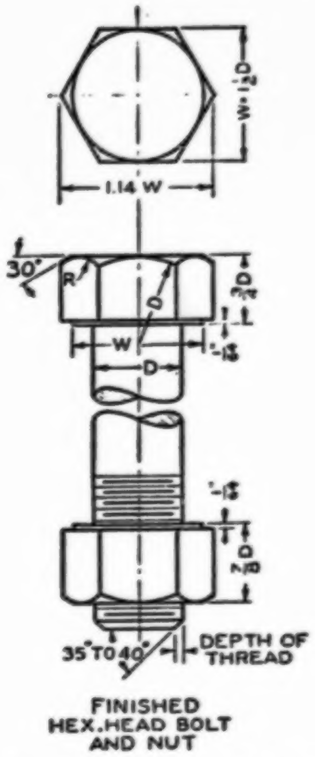
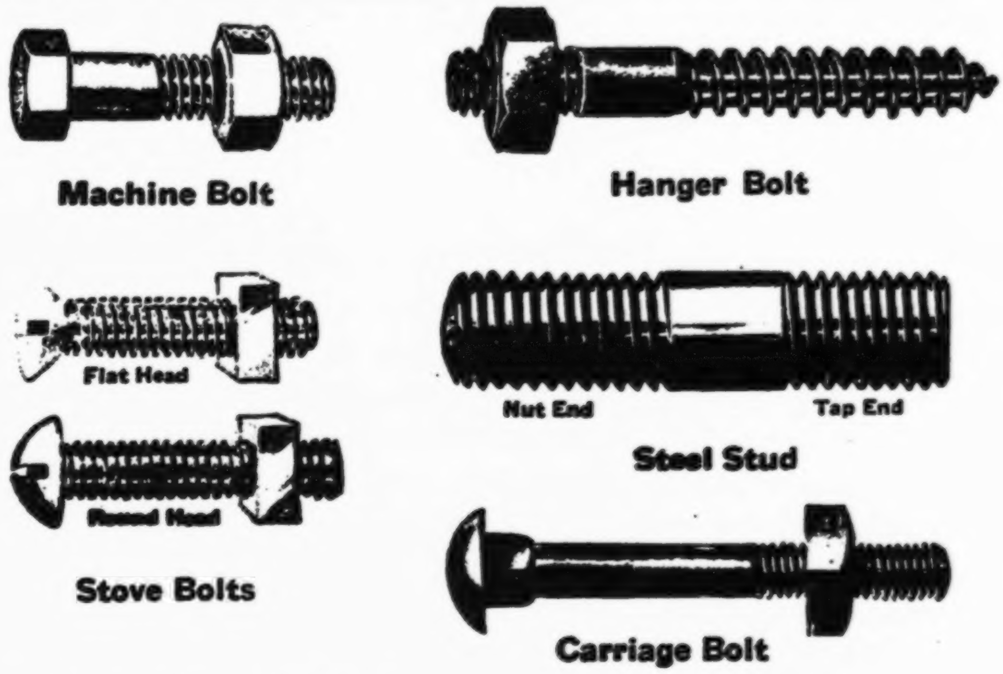

W=1½D
1.14 W
30°
R
D
W
D
35° TO 40°
DEPTH OF THREAD
FINISHED HEX.HEAD BOLT AND NUT

Figure 2. BOLT DIMENSIONS



Machine Bolt

Hanger Bolt

Flat Head

Round Head

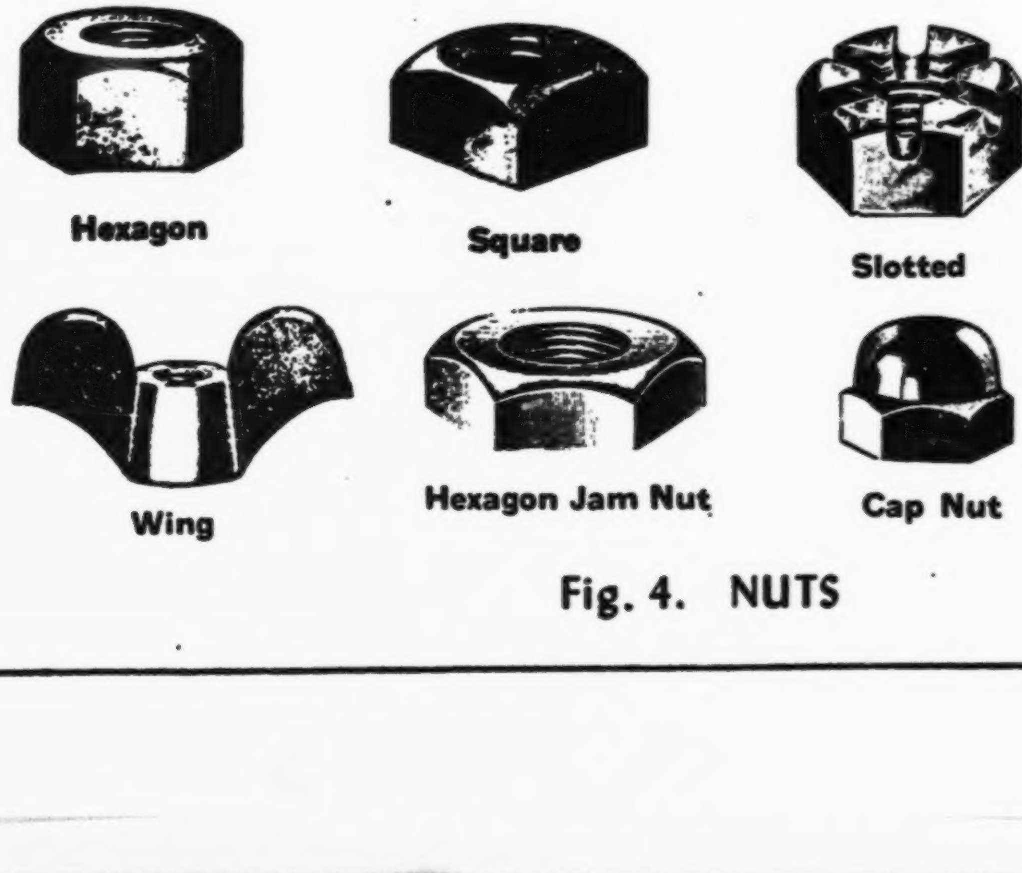
Stove Bolts

Nut End Tap End

Steel Stud

Carriage Bolt

Figure 3. BOLTS



Hexagon

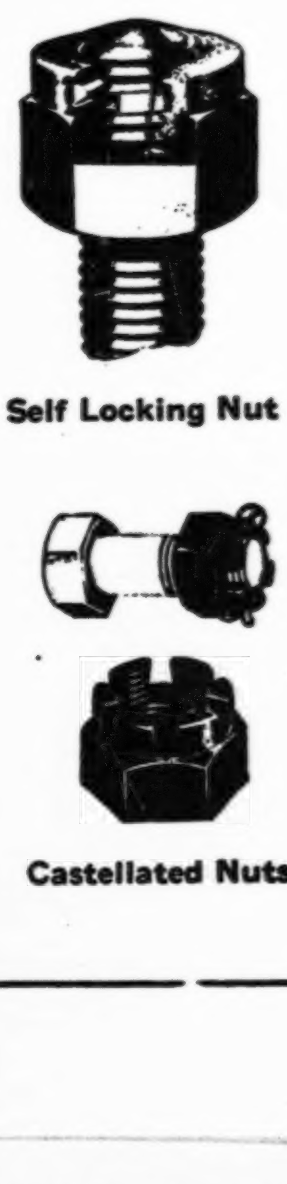
Square

Slotted

Wing

Hexagon Jam Nut

Cap Nut



Self Locking Nut

Castellated Nuts

Fig. 4. NUTS

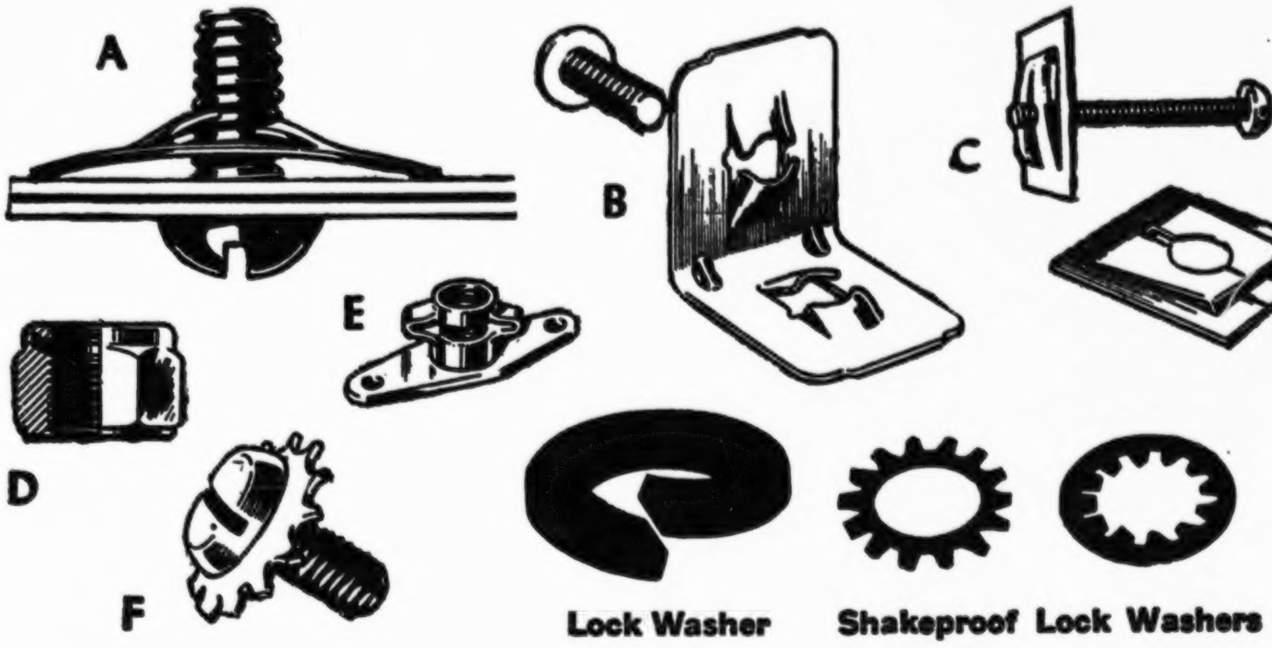

A
B
C
D
E
F
Lock Washer
Shakeproof Lock Washers

Fig 5 LOCK NUTS and WASHERS

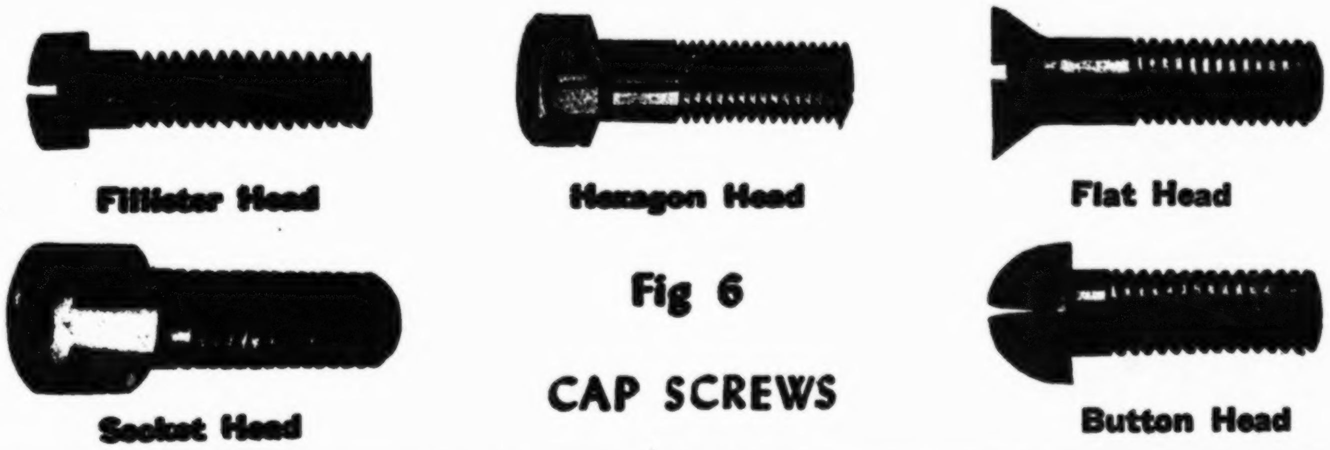

Fillister Head
Hexagon Head
Flat Head
Socket Head
Button Head

Fig 6

CAP SCREWS

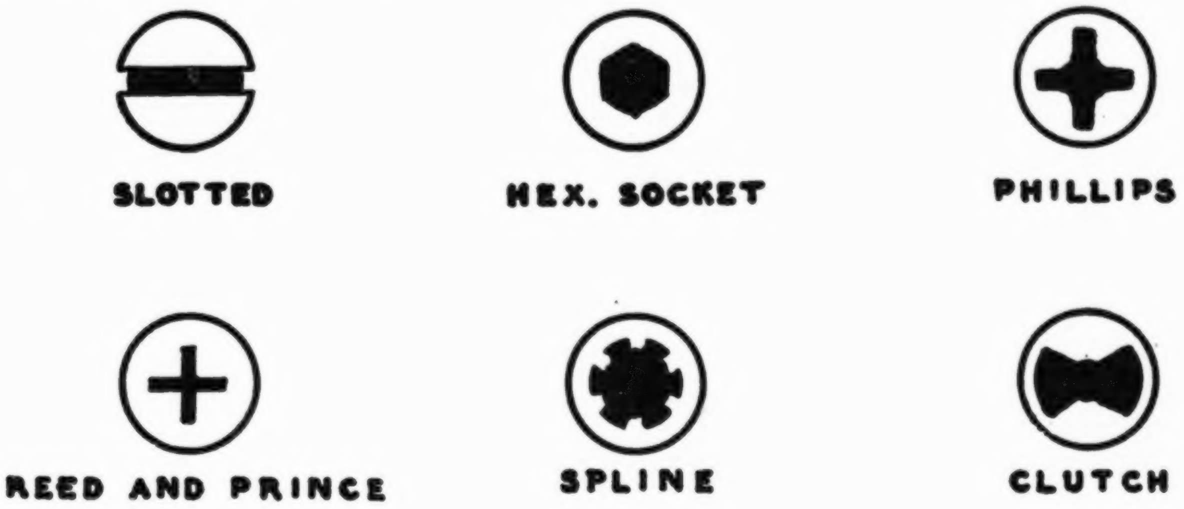

SLOTTED
HEX. SOCKET
PHILLIPS
REED AND PRINCE
SPLINE
CLUTCH

Fig 7 TYPES of RECESSED HEADS

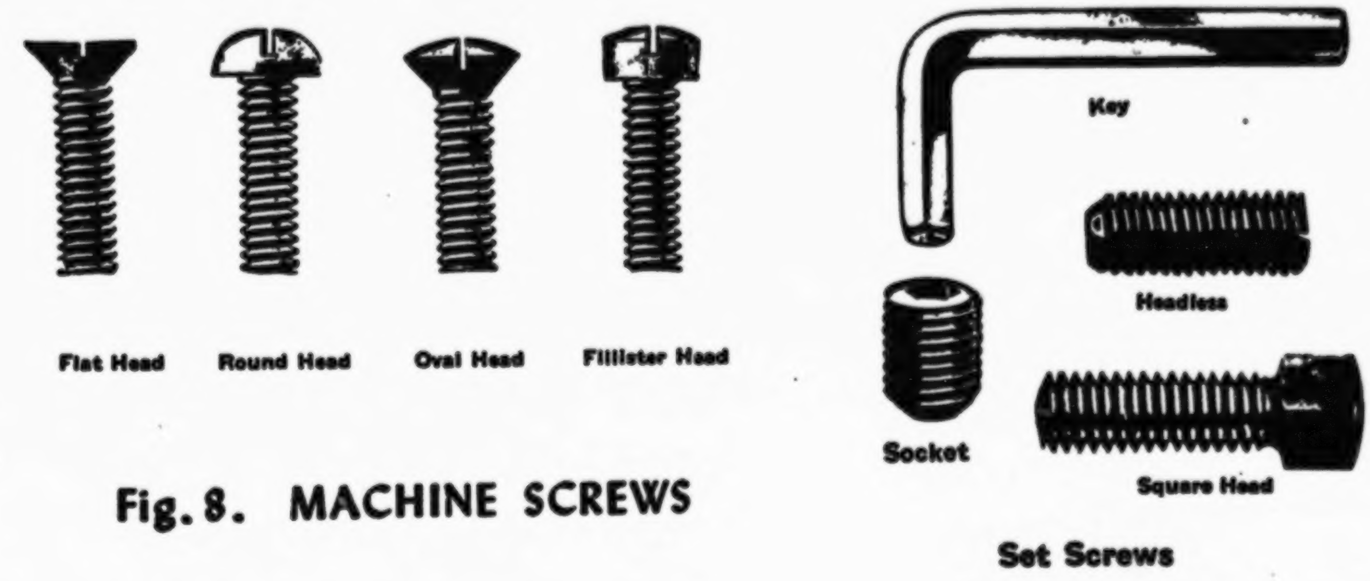

Flat Head
Round Head
Oval Head
Fillister Head
Key
Headless
Socket
Square Head
Set Screws

Fig. 8. MACHINE SCREWS

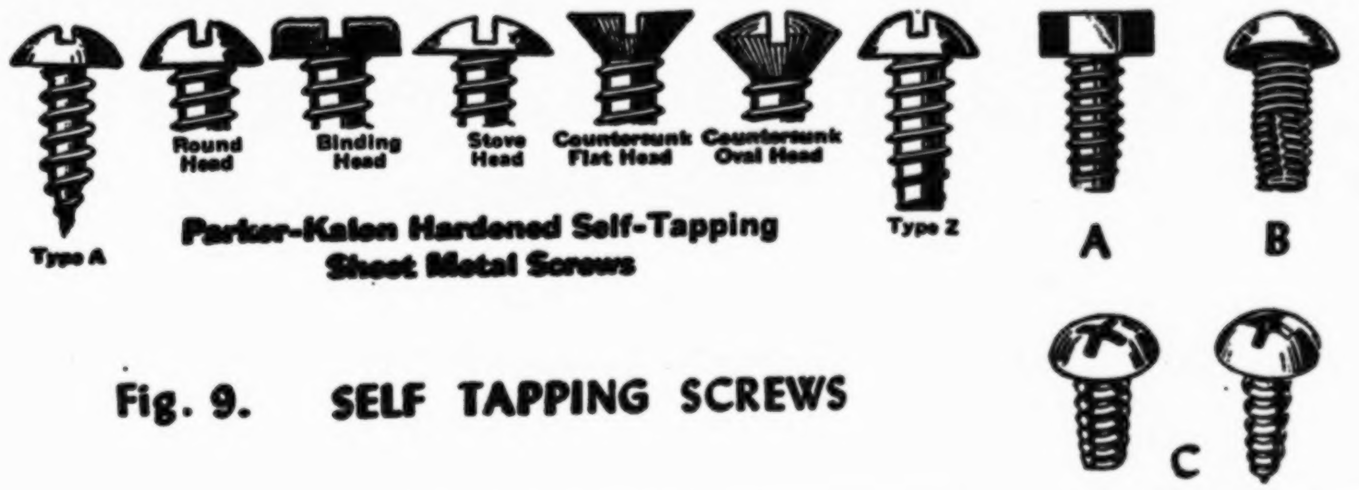

Round Head
Binding Head
Stove Head
Countersunk Flat Head
Countersunk Oval Head
Type A
Parker-Kalon Hardened Self-Tapping Sheet Metal Screws
Type Z
A
B
C

Fig. 9. SELF TAPPING SCREWS

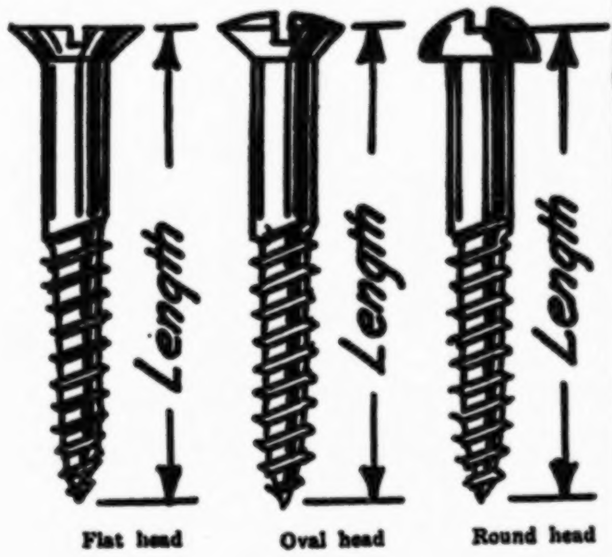

Length
Length
Length
Flat head
Oval head
Round head

Fig. 10. WOOD SCREWS

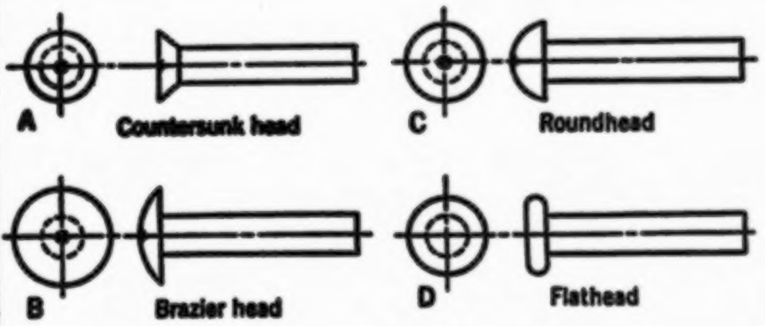

A
Countersunk head
C
Roundhead
B
Brazier head
D
Flathead

Fig. 11. RIVETS

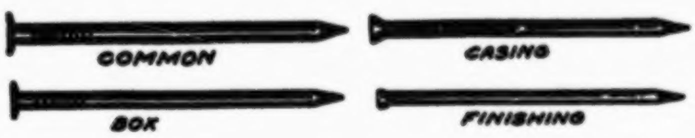

COMMON
CASING
BOX
FINISHING

Fig. 12. NAILS

UNIT: Introduction
TOPIC: The Parts of Machines
(Assignment Sheet continued)

IV. Fill in the blanks with a word or words to made a true, complete sentence.

1. The new standard system governing the manufacture of fastening devices used in this country is called the ________________________.

2. The two principal pitch series in this standard are ____________ and ____________.

3. The abbreviations for the above series are __________ and __________ respectively.

4. The meaning of "pitch" as applied to threads is: ____.

5. In the standard thread form, the basic angle between the sides of two threads is _____ degrees.

6. The head size of a standard hex bolt is the distance across opposite __________.

7. The nuts for standard bolts come in three thicknesses: ____________, _______, and ________.

8. The head size of a standard bolt is approximately _____ times its diameter.

9. The length of bolts is measured from _____________ to _______.

10. Bolts and their nuts are usually tightened by means of _______________.

11. Screws which are used to fasten light or thin metal sheets without the use of tapped holes are called ____________________.

UNIT: Introduction
TOPIC: The Parts of Machines
(Assignment Sheet continued)

12. Two other names for the above type screws are ________________ and ______________.

13. A short steel rod threaded on both ends is called a ________.

14. Thin washers with teeth around the inside or outside edges or both are called ________________ washers.

15. A thin nut which is used with a thicker one to keep it from loosening on the bolt is called ___________.

16. Enlarging and shaping the end of a pipe or metal rod, such as a rivet, is called ________________.

17. The three most common types of heads for set screws are _____________, _____________, and ________________.

18. The unit denoting the sizes of tinners' rivets is ________________.

UNIT: Introduction
TOPIC: The Parts of Machines
(Assignment Sheet continued)

11. ___ Cap screws are ordinarily used with nuts to fasten two pieces of metal.

12. ___ Bolts are sold with their nuts accompanying them.

13. ___ The most common type of cap screw is the hex head.

14. ___ The majority of screw pitches are uneven numbers.

15. ___ Most machine screws are of the coarse series.

16. ___ Machine screws ordinarily have threads the entire length of the shank.

17. ___ NC and USS may be used to designate American Coarse series threads.

18. ___ Stove bolts usually have hex nuts.

19. ___ Machine screws are smaller than cap screws.

20. ___ Carriage bolts are used to fasten wood to wood or wood to metal.

21. ___ Hanger bolts are used to fasten metal to metal.

22. ___ Castellated nuts are self-locking.

23. ___ Each type of recessed head screw requires a different type of screwdriver bit or wrench.

24. ___ Primarily, countersunk rivets are used in assembling aircraft to make them stronger.

25. ___ "Blind" rivets are so-called because they have no heads.

26. ___ The charge in explosive rivets is set off with an electric spark or sharp blow with a hammer.

UNIT: Introduction
TOPIC: The Parts of Machines
(Assignment Sheet continued)

III. Place + for TRUE and 0 for FALSE opposite the following statements:

1. ___ The form of a thread in the fine series is different to that in the coarse series.

2. ___ The hexagon head bolt and cap screws are the most used fastening devices in automobiles and modern machines.

3. ___ The distance across the flats of a standard bolt head determines its wrench size.

4. ___ The old U. S. Standard has been replaced by the American Standard.

5. ___ The American Standard Fine Series is also known as NF and SAE.

6. ___ Square headed bolts are used extensively in automobiles.

7. ___ The nut for any standard bolt will fit any standard screw of the same diameter and pitch.

8. ___ All bolts and screws tighten by turning clockwise.

9. ___ The thread standards used in this country also apply to foreign countries.

10. ___ Few bolts and screws have fractional numbers of threads per inch.

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Information Sheet
on
FASTENING DEVICES

THREADED FASTENERS

Distinction Between Bolts and Screws

Despite the progress made in standardizing machine parts, there is still considerable misunderstanding and confusion regarding the names, thread standards, and sizes of bolts and screws.

The public is inclined to make a distinction between two general types of threaded fastening devices, calling one "bolt" and the other "screw." Some manufacturers list every such device as "bolt" regardless of its size or type. Others may list a device as a "bolt" while other manufacturers may list the identical object as a "screw." While there is no single clearcut distinction between a bolt and a screw, there are a few generally accepted distinctions between them:

1. A bolt is usually thought of as a device used with a nut to fasten two parts together. A screw is usually thought of as a device for fastening two pieces together by passing through a hole in one and screwing into a tapped hole in the other, without the use of a nut. Bolts are usually sold with the nuts accompanying them, while screws are not provided with nuts.

2. The head (and nut) of a bolt is generally square or hexagon and is tightened by means of a wrench. The head of a screw is usually round in shape and is provided with a slot or some other means of tightening with a blade, such as a screwdriver. (Exception: hex cap screw)

3. The size of bolts is usually given in fractional inch sizes, such as 1/4", 5/16", etc., while the size of screws may be in fractional inch sizes, but is usually expressed in numbers from 0 to 30, which is the guage size of the steel wire from which the screws are made.

Fastening Devices
(Information Sheet continued)

Screw Threads

The threads on bolts and screws are spiral ridges made by cutting spiral grooves around the body of a cylindrical piece of metal stock. (See Figure 1.) These grooves are cut by means of a tool known as a die or by an automatic screw cutting machine which uses a die or chaser, and in the case of large sizes requiring accuracy, they may be cut on a lathe or on a thread milling machine. The shape of the groove (and hence the shape of the ridge) is determined by the shape of the cutting tool used, and it is obvious that this shape must be standard (always the same) or else bolts, screws, and nuts will not be readily interchangeable. The standard form for threads of bolts and screws is discussed in a later section.

In the following discussion, the term "screw" will not refer to the object known as a screw, but will refer to the threaded portion of any fastening device, whether it be a bolt, screw, or nut.

The pitch of a screw is the distance between corresponding parts of adjacent threads. The number of threads per inch can be measured with a rule as shown in Figure 1-A, which shows the number to be eight. Note that the first thread is not counted. Measuring the number of threads with a rule is difficult if there is not a full inch of threads; the reason being that if the number is odd, say thirteen, the half or quarter-inch graduation on the rule will be opposite a "valley" or groove of the thread and may be difficult to read.

The preferred way to measure pitch is with a screw pitch gage, shown in Figure 1-B. The pitch of a given screw is determined by mating the threads with the teeth of the proper leaf of the gage and then reading the pitch which is stamped on the leaf. The proper leaf is found by trial and error. The screw pitch gage can be used for finding the pitch of internal threads (as in nuts) as well as external threads.

The threads per inch for American (National) Standard threads are shown in Table 1. Such a table is quite useful in finding the proper screw for a certain tapped hole, for replacing a nut on a bolt, or for drilling and tapping a hole for a screw.

Fastening Devices
(Information Sheet continued)

Note that it can be seen from this table that practically all the number of threads per inch listed are not only whole numbers but are even numbers as well. In fact, there are only five odd-numbered threads per inch for screws of sizes No. 0 to 3" in the Coarse Series (13, 11, 9, 7, and 5), and there are none in the Fine Series. The only fractional number of threads per inch (4 1/2) is for sizes 2" and 2 1/4" Coarse Series.

Screw-Thread Form

By "thread form" is meant the shape of a thread that would be revealed if the longitudinal section bolt or screw were shown. There are about eight different thread forms recognized by the American Standard, most of them being used for special purposes. The thread form used almost exculsively in the manufacture of both bolts and screws is the American Standard, which is illustrated in the drawing to the right. Many foreign countries use different thread forms, making the exchange of such bolts and screws impossible.

$p = \text{pitch} = \dfrac{1}{\text{No. threads per in.}}$

$f = 1/8$ of p.

d = depth of thread

American Standard Thread Form

Screw Thread Series

The American Standard Thread Form is divided into two principal series: coarse and fine. The form of the thread is the same regardless of whether it is coarse or fine, the difference being in the number of threads in one inch for the same diameter screw or bolt. The designation of these two series is (1) American Standard Coarse (also known as NC and USS), and (2) American Standard Fine (also known as NF and SAE).

Thus a certain bolt, say a hexagon head, 1/4" in diameter, 2 1/2" in length, may have American Standard threads of either the coarse series (NC;USS) or the fine series (NF;SAE) and its description in a catalog will be:

Fastening Devices
(Information Sheet continued)

1/4 - 20 x 2 1/2 (NC or USS) Hex Head Bolt
1/4 - 28 x 2 1/2 (NF or SAE) Hex Head Bolt

The 20 and 28 have reference to the number of threads per inch for a bolt of 1/4" diameter in the course and fine series respectively.

For a bolt of larger diameter, say 1/2", it is necessary that the threads must be larger and fewer per inch for both the coarse and the fine series. In this case the thread description of the bolt will be:

1/2 - 13 x 2 1/2 (NC or USS)
1/2 - 20 x 2 1/2 (NF or SAE)

Definite standards have been set up governing the number of threads per inch for each size screw. The coarse series threads are used with machine bolts and screws for general industrial use, which, it is said, comprise about 80 % of all manufactured.

The fine series threads (or about 20% of machine screws) were adopted when it was found that the coarser threads would not stand up under the pressure and vibrations found in modern machinery, principally automobiles. The term SAE refers to "Society of Automotive Engineers," which was instrumental in the standardization of the machine screw threads.

For use in automobiles, the Society of Automotive Engineers adopted still another series, the Extra Fine thread series, for use in certain instances with thin metal where the thread engagement is small. In this series, a 1/2" screw will have 28 threads per inch, instead of 20 in the American Standard Fine series.

BOLTS

One of the most common types of fastening devices found in industry is the bolt, which is a steel rod, threaded on one end with a head on the other. The head is usually six-sided (hexagon or hex), and each side is called a "face," and the distance between any two opposite faces (flats) of the head determines the wrench size.

Fastening Devices
(Information Sheet continued)

Bolt Sizes

The dimensions of a bolt are determined by using its diameter (D) as the unit of measurement. This is shown in Figure 2.

1. The diameter of a bolt is the diameter of the body (not the head), the smallest being usually 1/4". The diameters range from 1/4" to 3".

2. The length of a bolt is measured from the underside of the head to the end and varies according to the use to which the bolt is put.

3. The head size of a bolt (W) is the wrench size and is the distance across flats. For standard hexagon machine bolts, it is equal to 1 1/2 times the diameter of the bolt. However, the bolts used by automobile manufacturers do not follow this formula exactly. An explanation of S. A. E. bolt and nut sizes is given in the Information Sheet, "Wrenches."

Designation of Bolt Sizes

When referring to bolts as in orders, parts lists, and correspondence, a standard manner of designating the necessary information is used, with the data listed in the following order:

1. Diameter
2. Length
3. Type thread
4. Finish
5. Type head
6. Name

This information is usually abbreviated as shown in the following example:

1/2" x 2 1/4" - 20NF - 2 Fin. -HEX. MACHINE BOLT

Types of Bolts

The most common types of bolts used for general industrial purposes are: (1) machine bolt, (2) stove bolt, (3) carriage bolt, (4) stud bolt (or stud), and (5) hanger bolt. All are shown in Figure 3 on the page of illustrations.

Fastening Devices
(Information Sheet continued)

NUTS

Nuts are of the same size, thread form, and pitch, as the bolt they fit. The standard hexagon nut is also the same diameter as the bolt head, but is somewhat thicker. The thread of a nut is internal (female), and the same standard thread systems apply to them as those previously discussed. Usually the sharp corners on square or hexagon nuts are chamfered to prevent injury to the hand.

Nuts are designed in several types to suit different needs. The most common types are pictured on the page of illustrations and are square, hexagon, slotted head hexagon, castle (or castellated), cap (also called acron and bline), and wing. The hexagon is by far the most-used nut in automotive work, and comes in three different thicknesses: Heavy (also called standard), light (also called half nut), and jam (also called lock). The jam nut is the thinnest and is used with another nut , usually a light or half nut, to lock it on the bolt.

Small thin nuts are sometimes incorrectly calles "taps" in certain parts of the country. (A tap is a fluted, threaded tool for cutting inside threads.)

Lock Nuts and Washers

Practically all nuts should be used with a washer of some type. However, some nuts have special safety devices which make this unnecessary. The slotted and castellated nuts (Figure 4) are used with cotter pins or safety wire to prevent them from loosening on the bolt. A few new type lock nuts, which were originally designed for the aircraft industry and which are now being used in other industries, are shown in Figure 5.

Spring steel nuts, such as those shown in Figure 5-A-B- C, are a class of nuts which are growing in popularity due to the fact that they can be installed very quickly and have the combined functions of nut and lock washer. The speed nut, Figure 5-A , has two forked prongs which engage the thread of the bolt and which are sprung inward to engage the bolt tightly when the nut is tightened. These nuts have numerous applications where no appreciable amount of strain is encountered, chiefly in radio and electrical installations and the assembly of parts made from plastics. They are made in angle brackets (Figure 5-B), as well as long metal strips with several "nuts" stamped at desired intervals.

Fastening Devices
(Information Sheet continued)

Another type of spring steel fastener is the "Stalock" fastener (Figure 5-C), which grips the thread almost one complete round. This nut may be re-used, whereas many other types are sprung with first use.

An altogether different type of lock nut is shown in Figures 5-D and 5-E. It has two threaded portions through which the screw turns, each being slightly out of "pitch" with the other, causing a compressive action as the nut is tightened.

Lock washers are of several types, the most common being the split ring type shown in Figure 5. Other types have come from the aircraft industry which required light weight washers with great "holding power" and the ability to withstand severe vibration. These are put into a general class known as "shakeproof" washers and come in two chief styles as shown in Figure 5. They have twisted, tapered teeth which engage both the nut and the work so as to make loosening unlikely. Those with teeth inside are for use with fillister head screws, while those with outside teeth are to be used with hexagon and square nuts and screw heads.

SCREWS

Methods of Driving Screws

Although a few types of screws are designed to be tightened with a wrench, the majority of them are provided with slots or sockets for engaging the blade or bit of a screwdriver or specially designed wrench. In recent years the trend has been away from the use of slotted head screws, the reasons being that the screwdriver blade must be properly formed and fit the slot snugly in order that the maximum amount of turning force can be applied without splitting or "chewing up" the screw head. Also, slotted head screws are difficult to start straight unless the screwdriver blade is exactly centered in the slot. The most popular types of driving devices used with screw heads (See Figure 7) and the names by which they are known are:

1. Slotted head for use with the conventional type screwdriver. One type of slotted head screw, used chiefly in radio work

(Figure 9-A), also has a hexagon head, making it suitable for both ordinary screwdriver or a "Spin-tite" wrench.

2. Hexagon socket head, also known as "Allen head," is used with the "L" shaped, hexagonal Allen wrench or key, shown in Figure 8.

3. Phillips head has a cross-shaped recess and is used with a Phillips screwdriver. Its chief values are ease of starting, attractive appearance, and the fact that the screwdriver cannot slip off the screw head while turning.

4. Reed-Prince head, also known as "croos head," is somewhat similar to the Phillips head and is used with a specially formed screwdriver bit.

5. Spline socket head, also called "fluted head," uses a special splined wrench which permits a maximum amount of force to be applied without splitting or straining the screw head.

6. Clutch head is used with a special screwdriverbit designed to permit considerable turning force. It is claimed that this type screw head makes starting screws in hard-to-get-at places easier since the screw will fit the bit snugly without falling off.

The recessed type of screw head was used principally with set screws and machine screws until a comparatively short time ago. Today, the use of such screw heads has been extended to almost every type of threaded fastening device, including stove bolts, self-tapping screws, and wood screws.

Needless to say, the universal use of special screw heads of the types described above necessitates the purchase of many different types and sizes of screwdrivers by the mechanic. The good mechanic always uses the correct type and size of driver for each specific screw.

Screw Specifications

Screws are designated in the same manner as bolts as shown in the example below:

Fastening Devices
(Information Sheet continued)

(Complete) No. 10 x 1 1/2" - 24-3FIN. FILL HD. MACHINE SCREW
(Abbreviated) 10 x 1 1/2" - 24 FILL HD. MACH. SCR.

(Complete) No. 3/8 x 2 1/2" - 24NG-3 FIN. NX. HD. CAP SCREW
(Abbreviated) 3/8 x 2 1/2" - 24 NF-HX. HD. CAP SCR.

Cap Screws

The largest screw for fastening two pieces of metal together is the cap screw, which passes through a clearance hole in one piece and fastens it by screwing into a tapped hole in the second piece (See Figure 6). They are available with threads of either the American Standard Coarse or Fine series and in sizes from 1/2" to 1" and over. The lengths are usually from 1/2" to 6".

The heads of cap screws are in five general types: hexagon (the most common), flat, button, fillister, and socket (or recessed).

Machine Screws

Machine screws - shown in Figure 8 - are similar to cap screws in shape and head type, but differ principally in the fact that they are smaller (usually in sizes from Nos. 0 to 12) and have threads of only the coarse series. As a rule, machine screws are threaded all the way from the head to the end.

Set Screws

Set screws (Figure 8) are fastening devices used to set a wheel, collar, or hub on its shaft. They are usually headless, although some come with square heads. The headless type is provided with slots or hexagon sockets for scresing them into the hub so that none of the screw projects on the outside. The diameter of the socket is, in nearly all cases, half the diameter of the screw.

The points of set screws are of several types: flat, cup, cone, oval, and dog. The same standard thread systems apply to set screws as those previously discussed.

Fastening Devices
(Information Sheet continued)

Right and Left Hand Threads

All bolts, screws, and their nuts are right hand (RH) unless specified left hand (LH). Right hand means that the nut is turned in the right hand (clockwise) direction to tighten it.

Left hand screws are used only when required, as, for example, when the nut is in contact with a part turning in a counter-clockwise direction and the friction tends to loosen a right hand nut.

Self-Tapping Screws

Self-tapping screws, also called "Parker screws" and "Sheet metal screws," resemble ordinary wood screws except that they are shorter and have threads the entire length of the screw. They are used principally in fastening thin metal parts and sheet metal together, but are also used with plastics. The screws are of very hard metal, and the threads "form" rather than "tap" threads into the metal into which they are screwed. There is a type, however, which actually taps threads into a drilled hole. It resembles a machine screw with "interruptions" or slits along the end which present cutting edges at each thread, which tap the threads as the screw is tightened. (See Figure 9-B.)

Parker self-tapping screws are made in two types, "A" and "Z", and are available with six different types of heads, (See Figure 9), each of which may have the slotted or Phillips recessed head, as shown in Figure 9-C.

Drive Screws

Drive screws are a combination of screw and nail. They are used chiefly to fasten sheet metal, plastics, leather, and paper to wood by driving them nearly home with a hammer and tightening with a screwdriver a turn or two.

One type of drive screw, designed for metal work, is made of hardened steel and is used to fasten thin metal parts to brass, aluminum, and iron castings by driving the screw all the way home with a hammer after it has been started in a hole drilled to the proper size to receive it.

Fastening Devices
(Information Sheet continued)

4. Flat head rivets are used for general purposes where both strength and compactness are important. Tinners' rivets are of this type and are made of soft steel and are usually tinned to prevent rusting.

Special Rivets

One of the chief drawbacks to the use of ordinary rivets is the fact that both sides of the work must be accessible for driving and bucking. For places where only one side of the work can be reached, several patented "blind" rivets are available, most of which use a metal screw or plug inside the hollow rivet which compresses and upsets the end when the screw or plug is withdrawn. One type of "blind" rivet uses a small explosive charge in the hollow end which explodes when heat is applied to the head, thus upsetting the end of the rivet.

Size of Rivets

The size (diameter) of rivets is expressed in three manners:

1. Fractional inch sizes
2. Gauge
3. Weight

The size of aluminum rivets is given in fractional inch sizes, usually in 32nds, and the length of the shank is usually expressed in 16ths of an inch,

Tinners; rivets have standard lengths for each size, which is expressed in weight. The weight, such as 6 ounces, 1 pound, and the like, represents the number of ounces or pounds that 1000 such rivets weigh. The smallest size is 6 ounces (1000 weigh 6 ounces). and the largest is 3 pounds.

Material for this information sheet was taken from "Fastening Devices For General Industrial Metal Shop", pp. 1 - 10.

Fastening Devices
(Information Sheet continued)

RIVETS

Use of Rivets

Rivets are used to fasten together two pieces of metal which will not likely require disassembling later. Riveting is the "upsetting" the end of the rivet shank which has been passed through punched or drilled holes in the metal pieces. "Upsetting" is the forming of a second head by shaping the end of the rivet in several different ways while the head is held firmly in place ("bucked") with a bucking bar or dolly which is usually held by another person.

Before the development of welding, riveting was practically the only method of fastening two pieces of heavy metal together permanently. Today, the use of large steel rivets is chiefly limited to structural steel and boiler work in which the steel rivets are driven red-hot. Only the "soft rivets," which are made of aluminum, copper, and other soft metals and which can be driven cold, will be discussed here. The ends of such rivets are "upset" by hammering or peining, with hammer and a rivet set, and with pneumatic hammers called rivet "guns."

Types of Rivet Heads

The most common types of rivet heads are shown in Figure 11. In general, each type is used for the following types of work:

1. Countersunk rivets are used where streamlining is necessary to prevent "drag" due to air or water flow, and for appearance. The principle of countersinking used with wood and metal screws is used with rivets, permitting the heads to be flush with the surface of the metal.

2. Brazier head rivets are used chiefly in aircraft assembling and repairing where countersinking is not practical and where "drag" must be kept as low as possible by making the rivet heads thin.

3. Round head rivets are used where maximum strength is important and "drag" and appearance are of little concern.

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Introduction

TOPIC: Transmission of Power

OBJECTIVE: To develop an understanding of the ways that power is transmitted from its origin to use.

INTRODUCTION: Power remaining at the source of production is of no value to the operator. To utilize this power it must be transferred by some method to a place of adjustment and use. Often times it is necessary to adjust power into several speeds to fully utilize it. In this assignment the methods of transmitting this power will be studied.

REFERENCES: Required:

1. Farm Machinery and Equipment, H. P. Smith, Ch. 4.

Supplemental:

2. Modern Farm Power, pp. 182-187.
3. Farm Gas Engines and Tractors. pp. 404-445. 475-479.

QUESTIONS or ACTIVITIES:

1. What are the six methods of transmitting power in connection with farm equipment?
2. What is the advantage of a V-belt over flat belts?
3. When is a V-belt properly fitted?
4. How can belt lengths be determined?
   a. V-belt
   b. Flat belt
5. What formula may be used to calculate the speed or size of pulley?

UNIT: Introduction
TOPIC: Transmission of Power

6. Explain how the pitch of the sheave will vary speeds.

7. Explain the proper direction of travel when using a pressed-steel hook chain.

8. List the names of the types of gears that are shown in figures 4-17, page 34 in the Farm Machinery and Equipment, Smith.

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910-I-8

Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT:	Introduction
TOPIC:	Tractor Design
OBJECTIVE:	To develop an understanding of different types and sizes of farm tractors.

INTRODUCTION: The tractor is the farmers "power house". It is a moveable powerhouse. Most all farm machines can be operated by the tractor and many other attachments can also be used such as grader and ditcher blades, manure loaders, scoops, power shovels, post hole diggers, wood saws, load carriers and many others. Each implement attached must "match" the tractor in size and capacity.

Farmers are the principle users of tractors. In a recent ten (10) year period, the number of tractors used by farmers almost doubled which shows how rapidly our farming is being mechanized.

REFERENCES: Required:

1. Machines for Power Farming, John Wiley and Sons, Ch. 2.
2. Farm Tractors, FT-53-Humble, page 3.

Supplemental:

3. Farm Power, Moses and Frost, pp. 289-304.
4. Tractors and Crawlers, Frazee and Bedell, Ch. 1.
5. Operation, Care and Repair of Farm Machinery, John Deere and Company.

UNIT: Introduction
TOPIC: Tractor Design
(Assignment Sheet continued)

QUESTIONS or ACTIVITIES:

1. What are the major types of tractors?
2. What type is most popular? Why?
3. What are the ways of rating sizes of tractors?
4. In what ways are all tractors alike?
5. What are the basic elements of all farm tractors?

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910-II-1

Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT:	Internal Combustion Engines
TOPIC:	Theory of Operation
OBJECTIVE:	To develop an understanding of the process involved in transforming fuel to power in a two cycle and four cycle engine.
INTRODUCTION:	Do all engines have spark plugs? Of course, the answer is no. Do all engines have valves? Again the answer is no. We would then say it is apparent that engines differ in physical characteristics. It should be just as evident that differences exist between different types of engines in the process of transforming fuel to power. To be a good mechanic one must not only be able to recognize the different types of engines by the types of fuel and number of strokes per cycle but must have a good understanding of why and how each operate. In this assignment we are concerned with understanding exactly what happens on each stroke for both the two and four cycle engines.
REFERENCES:	Required:

1. Information Sheet, "Two and Four Stroke Cycle Engines".
2. "Farm Tractors-Basic Principles, Operation, and Maintenance", Engineering Bulletin No. FT-53, pp. 3-7.
3. Selecting and Storing Tractor Fuels and Lubricants, American Association for Agricultural Engineering and Vocational Agriculture, pp. 3-5.

UNIT: Internal Combustion Engines
TOPIC: Theory of Operation
(Assignment Sheet continued)

Supplemental:

4. "Briggs and Stratton Corporation", MS3553-24, page 3

5. Modern Farm Power, Bromensherger and Bishop, Ch. 2

QUESTIONS or ACTIVITIES:

1. What is a four cycle engine?

2. What is a two cycle engine?

3. Explain the operation of a four cycle carburetor type engine.

4. Explain the operation of a two cycle carburetor type engine.

5. How is lubrication provided for in a two cycle engine?

VOCABULARY: The following key words or terms have been used in this assignment and should now be a part of your vocabulary. Explain or define each.

Intake valve

Exhaust valve

Piston

Crankshaft

Spark plug

Cylinder

Connecting rod

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910-II-1

Information Sheet
on
TWO AND FOUR STROKE CYCLE ENGINES

The first successful four-stroke cycle internal combustion engine was developed by a German in 1876. An Englishman patented a two-stroke cycle engine in 1878. Experimentation on various systems of converting heat to power had been underway in various countries for at least 200 years prior to the successful development of an internal combustion engine. In some of the early experiments gun powder was used as fuel but did not prove practical.

Power which is used to move the tractor is created within the cylinders of the engine and transmitted through the crankshaft, transmission, differential, and final drive to the rear wheels. The way the power is utilized after it is produced by the engine is determined by the power transmitting systems attached to the engine. However, regardless of the kind of work which is done by the power, whether it is pumping water or powering a self-propelled combine, the origin of power is still the same--that is through the combustion of fuel and air within the cylinders of an engine. See Figure 6, page 4, reference 2, for an illustration of the conversion of compressed air-fuel mixture to power. Since the piston is attached to a connecting rod, which is attached to a crankshaft in an offset position from the center of the crankshaft, the force exerted on the piston by combustion drives the piston downward causing the crankshaft to turn. This represents rotary motion.

Internal combustion engines are of two types: two-stroke cycle and four-stroke cycle. A STROKE includes that movement of the piston from the top of the stroke (T DC--Top Dead Center) to the bottom of the stroke (CDC--Crank Dead Center) or from CDC to TDC. This means that with each complete revolution of the crankshaft the piston moves from a point back to that point, for example TDC to TDC, and has made two strokes.

A CYCLE is composed of the number of strokes required for a complete series of events from the point the cylinder is ready to receive the fuel-air mixture (carburetor engine) or the air only (diesel engine) to the point at which the spent gases are expelled from the cylinder and is ready to receive a new supply of fuel-air mixture or air. A two-stroke cycle engine requires two strokes for this process. A four-stroked cycle engine requires four strokes to complete a cycle. It is common terminology to refer to 2-cycle or 4-cycle engines; in this case the 2 and 4, respectively, refer to the number of strokes required for a complete cycle of events.

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910-II-2

Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Internal Combustion Engines

TOPIC: Engine Types

OBJECTIVE: To develop an understanding as to engine types classified according to blocks, valves, cylinders and fuels, as well as basic engine parts.

INTRODUCTION: Successful farm machinery repairmen know that farmers today depend upon machinery to a very great extent. One of the basic elements of all farm power machinery is the engine. This may be a gasoline or diesel depending upon the owners choice. Basically both engines are constructed and operate similarly. To be able to better understand the operation of an engine a person needs to be familiar with its basic construction and parts.

In this topic we explore the basic engine parts, methods of classification and some materials used in the parts.

REFERENCES: Required:

1. Machines for Power Farming, Stone and Gulvin, Ch. 3
2. 'Farm Tractors,' Engineering Bulletin, No. FT53, pp. 3-9.

Supplemental:

3. Diesel and High Compression Gas Engines, Kates.

QUESTIONS or ACTIVITIES:

1. How are engines classified according to fuel?
2. What four systems are necessary to make an engine?
3. What are the principal engine parts?

UNIT: Internal Combustion Engines
TOPIC: Engine Types
(Assignment Sheet)

4. How do diesel and carburetor type engines differ in block construction?
5. How are engines classified according to cylinders?
6. How are engines classified according to blocks?
7. How do valves vary within engines?
8. How do diesel and carburetor type engines differ in operation?

VOCABULARY: The following words were used in this assignment and should be part of your vocabulary. Define the following:

1. Bore
2. Stroke
3. Piston displacement
4. Intake valve
5. Exhaust valve
6. Piston
7. Crankshaft
8. Spark plug
9. Cylinder
10. Connecting rod
11. Fuel injection

910-II-3

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Internal Combustion Engines

TOPIC: Power Measurements

OBJECTIVE: To develop an understanding of the amount of power which is developed by an engine and how this power is measured.

INTRODUCTION: What is horsepower? What is "Brake Horsepower"? What is "Draw-bar Horsepower"? Do you know how to measure each of these? When dealing with farm machinery, it is important that this information be familiar to you.

In this assignment we will be concerned with measuring horsepower at the various locations of the tractor.

REFERENCES: Required:

1. Farm Tractors, FT-53, pp. 98-100
2. Machines for Power Farming, Ch. 7

Supplemental:

3. Tractors and Crawlers, Frazee and Bedell, Ch. 1, pp. 13-24
4. Farm Gas Engines and Tractors, Jones, Ch. 5, page 45

QUESTIONS or ACTIVITIES:

1. Define horsepower.
2. What is a btu and what is its relationship to horsepower?
3. Although the tractor is the source of power, what is required to make use of the power?

UNIT: Internal Combustion Engines
TOPIC: Power Measurements
(Assignment Sheet continued)

4. Where are the four main points of measurement of horsepower on a farm tractor?

5. Why is "indicated horsepower" different to "brake horsepower"?

6. What conditions affect the calculating of drawbar horsepower?

7. If 32% of the potential heat energy of the fuel is lost through exhaust and 40% is lost in the cooling water, what is the remaining 28% known as?

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910-II-4

Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Internal Combustion Engines

TOPIC: Power Plant Construction and Terminology

OBJECTIVE: To develop an understanding of how and why power plants are designed and constructed as they are and to develop the ability to refer to the parts using the proper terminology.

INTRODUCTION: Do you know why the engine in a tractor is designed as it is? Do you know how to properly care for that engine? An understanding of basic engine construction and the correct terminology to use is essential in gaining the skill necessary to work on an engine. It does not matter how good an engine is constructed, it will not be efficient in its operation unless you have the ability and skill to operate and maintain it correctly. In this exercise we will study the relationship of one part to another and the function of each part to complete and make possible the function of the whole engine.

REFERENCES: Required:

1. "Machines for Power Farming," Chapter 3
2. Information Sheet
3. Service manual for respective tractor being studied

Supplemental:

4. "Briggs & Stratton," bulletin
5. "Farm Tractors", Humble bulletin

QUESTIONS or ACTIVITIES:

1. Cylinders are often known as the ____________ of the engine
2. Each cylinder is an airtight chamber, closed on one end by the ____________________ and at the opposite end by the ______________ .

UNIT: Internal Combustion Engines
TOPIC: Power Plant Construction and Terminology
(Assignment Sheet continued)

3. The piston and connecting rod assembly is made up of a number of parts. Identify these parts on the attached illustration.

4. What is the purpose and advantage of a cylinder liner?

5. Identify the parts of a cylinder head and related parts on the attached illustration.

6. Identify the parts of the crankshaft and related parts on the attached illustration.

7. Identify the parts of a camshaft and related parts attached.

8. Study the parts of the valve assembly which is attached and be able to identify each.

9. Identify the parts of a cylinder block and its related parts as shown on the attached illustration.

10. Identify the parts of the rocker arm assembly as illustrated on attached sheet.

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910-II-4

Information Sheet
on
POWER PLANT CONSTRUCTION AND TERMINOLOGY

Gasoline engines are composed of many small parts. Each part serves a specific function or, in many cases, several functions. The efficient tractor mechanic must have a thorough understanding of the many parts of a gasoline engine and the functions they perform.

Because of the peculiar function of each part, each falls into a natural group, referred to as an assembly or a system.

Gasoline engines may be grouped into the following systems:

1. Stationary parts
    a. Cylinder block
    b. Cylinder head
    c. Crankcase
    d. Oil pan
    e. Cover
2. Moving parts
    a. Pistons and rings
    b. Connecting rods and wrist pins
    c. Crankshaft
    d. Main bearings
    e. Flywheel
    f. Camshaft and camshaft gear
    g. Valves
    h. Rocker arm assembly
    i. Oil pump and accessories

Powet Plant Construction and Terminology
(Information Sheet continued)

3. Electrical system
    a. Battery
    b. Generator and charging circuit
    c. Ignition circuit (distributor, coil, spark plugs, breaker points, condensor and magneto)
    d. Cranking motor (starter)
4. Fuel, air, and exhaust systems
    a. Air cleaner
    b. Fuel tank
    c. Fuel line, cut-off valve, strainer, and filter
    d. Fuel pump (only in tractors that do not have the fuel tank located above the engine)
    e. Carburetor
    f. Manifold, muffler, and exhaust pipe
    g. Governors
5. Cooling system
    a. Radiator, hose, and pressure cap
    b. Water pump
    c. Thermostat
    d. Fan

Tractor engines may be grouped into four basic classes, classed according to fuels. These are: (1) gasoline, (2) distillate, (3) LP gas and (4) diesel. Although these engine classes require different fuels basically the engine is constructed very similar.

Power Plant Construction and Terminology
(Information Sheet continued)

The cylinder block is the basic frame of the engine. It supports all the components in relation to one another and maintains them in alignment. The most important requirement of the cylinder block is rigidity. In most cases, tractor engines are made of cast iron alloy.

Cylinder blocks may vary in design. They may be of the integral bore type; that is, the cylinder bore is machined directly into the material of the block. It may have separate and removable cylinder sleeves. The removable sleeve may be of the wet type (the coolant comes in direct contact with the outer surface of the sleeve), or it may be of the dry type (the sleeve or liner is inserted in the bore and is not in direct contact with the coolant).

Valve-in-block engines have the valve seats, ports, and guides in the block casting with their respective water jactets; whereas, the 1-head engine block has only the cylinder bore water jackets.

If the block skirt extends only to the center line of the crankshaft main bearing, it is known as a "short skirt." If it extends below the center line of the crankshaft main bearing, it is known as a "deep skirt."

Many engine blocks may have oil galleries cored in. Others may have steel tubes inserted to act as galleries; whereas, others may have oil lines and fittings to carry oil to the various parts.

As a rule, the cylinder head is made of the same material as the cylinder block. It serves as a cap and is attached to the top of the engine block and covers the upper cylinder openings, thereby forming a combustion chamber.

The crankcase is the lower part of the cylinder block; it confines the lubricating oil near the engine's moving parts in the four-cycle engine. It also supports the crankshaft and camshaft bearings.

The oil pan serves as a reservoir to hold the crankcase lubricant and seals the lower part of the engine in the four-cycle engine.

Various types of covers are used on the timing train, the valve train, and sometimes on other components or inspection-holes. They are usually made of stamped steel.

Power Plant Construction and Terminology
(Information Sheet continued)

The moving parts of the engine that receive the gaseous energy produced in the combustion chamber and deliver it to the output end of the engine in the form of useful power are referred to in this module as the moving parts.

1. Pistons and rings

   Cylinders are sealed and the gaseous pressure transmitted to the connecting rod by the piston and its rings.

   The top section of the piston is the crown, and the lower section is the skirt.

   The upper set of rings, compression or power rings, are carried by the crown of the piston. The lower set of rings, oil control rings, are carried by the skirt of the piston.

2. Connecting rods and wrist pins

   A connecting rod is a bar or strut with a bearing at each end. The purpose of the connecting rod is to transmit the piston thrust to the crankshaft.

   The connecting link between the connecting rod and the piston is the wrist pin.

   There may be three arrangements of wrist pins.

   a. The wrist pin is secured in the piston, and the bearing is held in the connecting rod end.

   b. The wrist pin is fastened to the connecting rod, and the bearing is part of the piston.

   c. The wrist pin is free and bears against bearings in both the piston and the connecting rod.

3. Crankshafts

   Crankshafts deliver force to the transmission and power train as a result of the thrust from the connecting rod.

   Some crankshafts are designed with counterweights opposite the crank pins. These relieve the load on the main bearing by offsetting the inertia forces.

4. Bearings

The purpose of bearings is to support rotating shafts and other moving parts that transmit power from one engine part to another.

Bearings reduce the friction between the moving surfaces by separating them with a film of lubricant and carry away the heat produced by unavoidable friction.

5. Flywheels

The flywheel is a heavy wheel or disk attached to the crankshaft Through rotation, the flywheel acquires kinetic energy It stores additional kinetic energy when it speeds up and gives back that energy when it slows down

The main purpose of the flywheel is to reduce the speed fluctuations of the crankshaft, caused by the difference in the amount of energy exerted on the piston during the power stroke and during the compression stroke.

Single-cylinder engines require larger flywheels than multi-cylinder engines, because energy variations during a complete cycle are greater in single-cylinder engines.

6. Camshaft and gear

The camshaft is a lobed shaft which provides accentric action for opening the valves. It is driven from the crankshaft by a timing gear or through a timing chain.

7. Valves

The purpose of valves is to open and close ports in the combustion chamber. Since there are two ports for each cylinder, there must be two valves. The intake valve allows the fuel-air mixture to enter the chamber when the valve is open. Exhaust valves open to allow burned gases to escape from the combustion chamber into the exhaust system. Both valves are closed on the compression and power strokes.

8. Rocker arm assembly

The purpose of the rocker arm assembly is to actuate the valves at the proper time. The rocker arm assembly is actuated by the camshaft and consists of valve lifters, push rods, rocker arms rocker arm shaft brackets, rocker arm shaft and accessory parts.

9. Oil pump and accessories

The oil pump is located in the oil pan. Its function is to provide engine lubrication. Pümps are of three types: vane, piston, and gear. Because of their long life and trouble-free operation, gear pumps are used in most engines.

In many engines, oil filters are located between the oil pump and the engine parts to remove abrasive particles.

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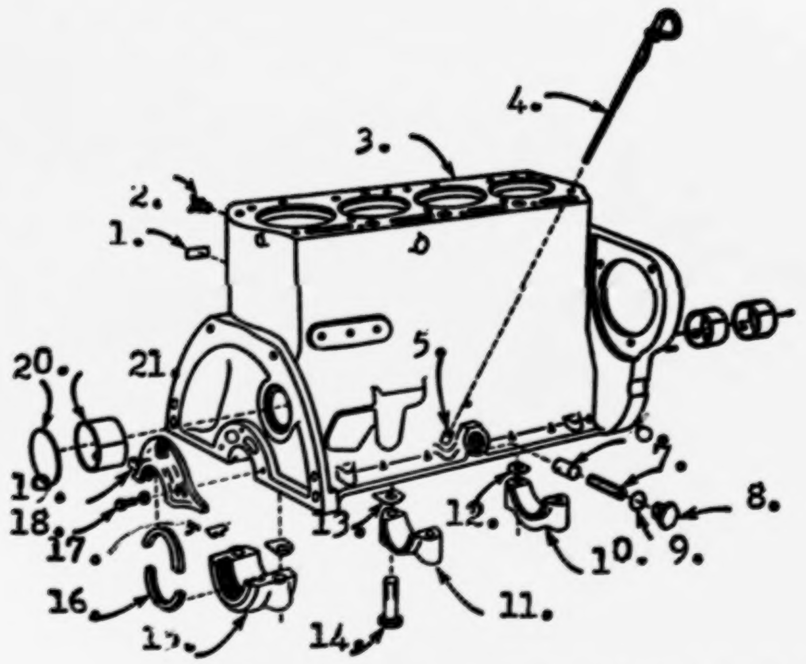
Material for this Information Sheet was partially taken from GASOLINE TRACTOR ENGINE SYSTEMS, Agricultural Machinery-Service Occupations Module No. 14, The Center for Research and Leadership Development in Vocational and Technical Education, Columbus, Ohio, 43212.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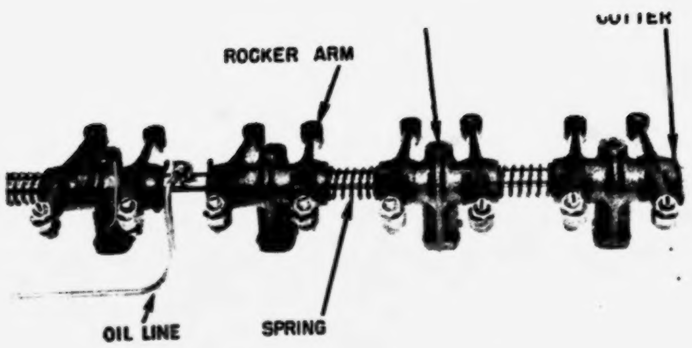
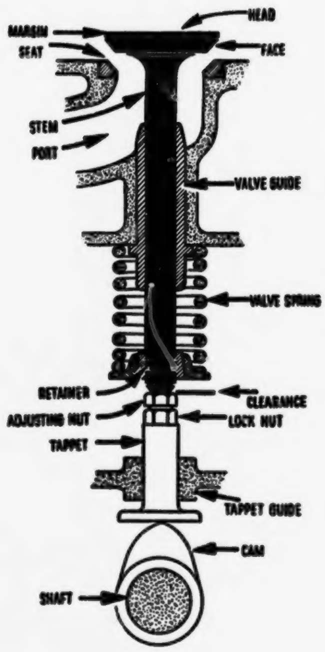
Cylinder block and related parts (Allis-Chalmers Mfg. Co.).


COTTER
ROCKER ARM
OIL LINE
SPRING

Rocker arm assembly

Courtesy: Oliver Corporation


HEAD
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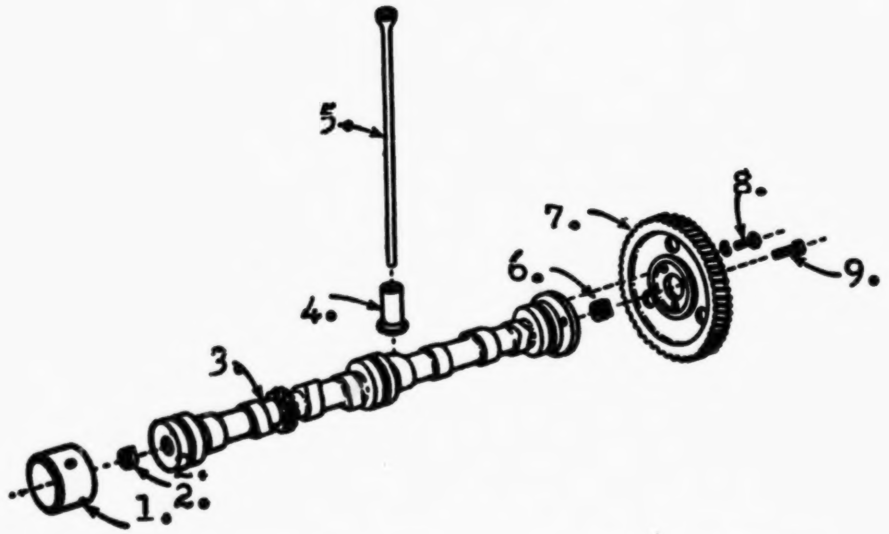
PORT
VALVE GUIDE
VALVE SPRING
RETAINER
CLEARANCE
ADJUSTING NUT
LOCK NUT
TAPPET
TAPPET GUIDE
CAM
SHAFT

The L-head valve assembly.
Courtesy: Black and Decker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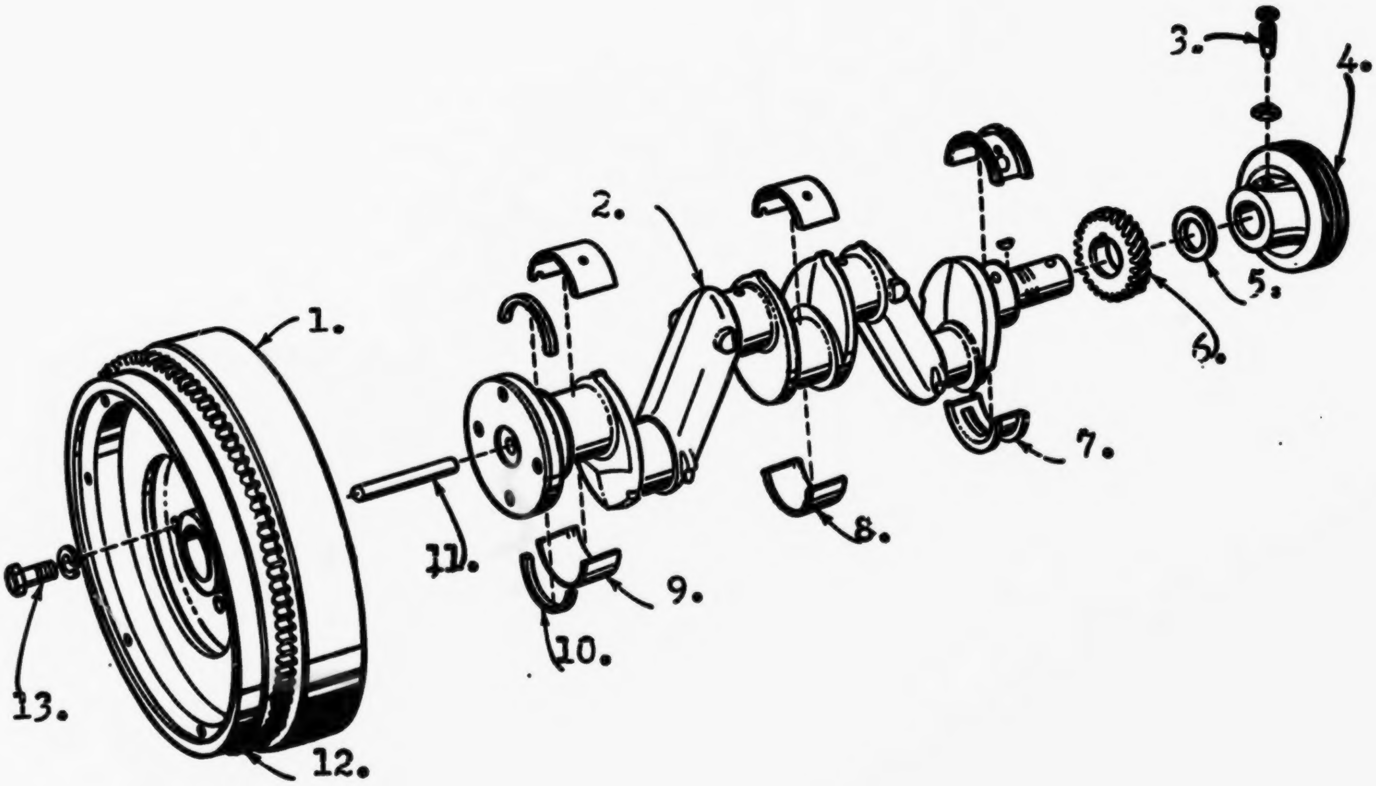
Camshaft and related parts (Allis-Chalmers Mfg. Co.).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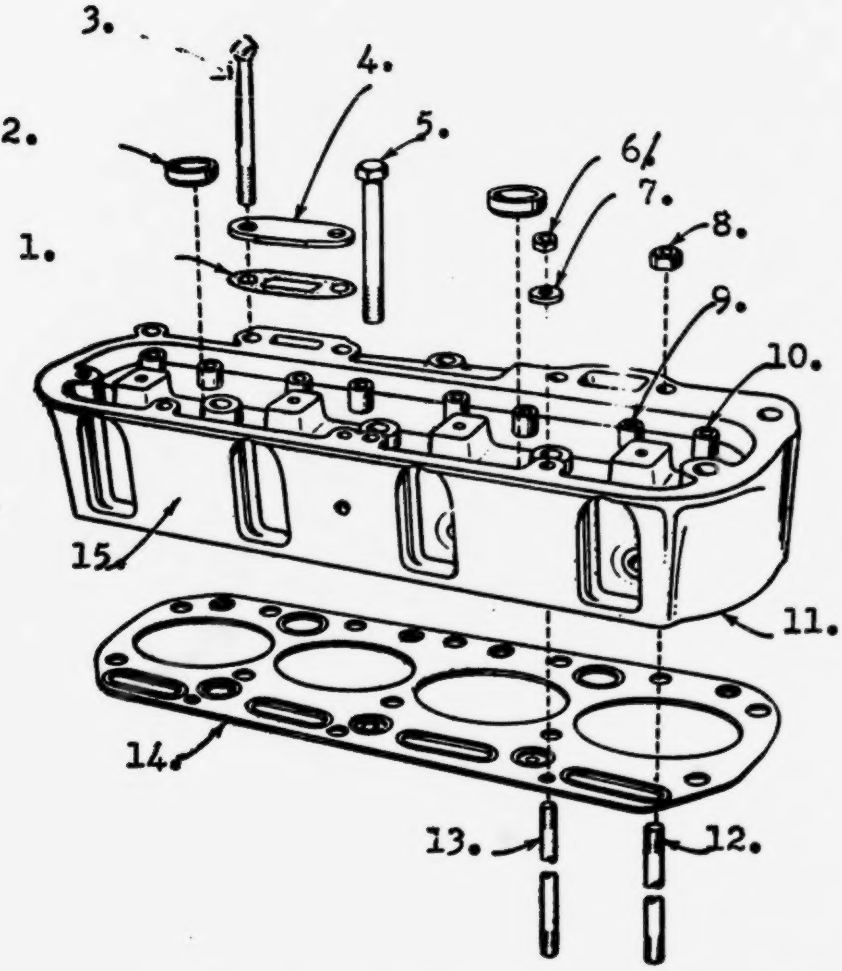
Crankshaft, flywheel, and related parts (Allis-Chalmers Mfg. Co.)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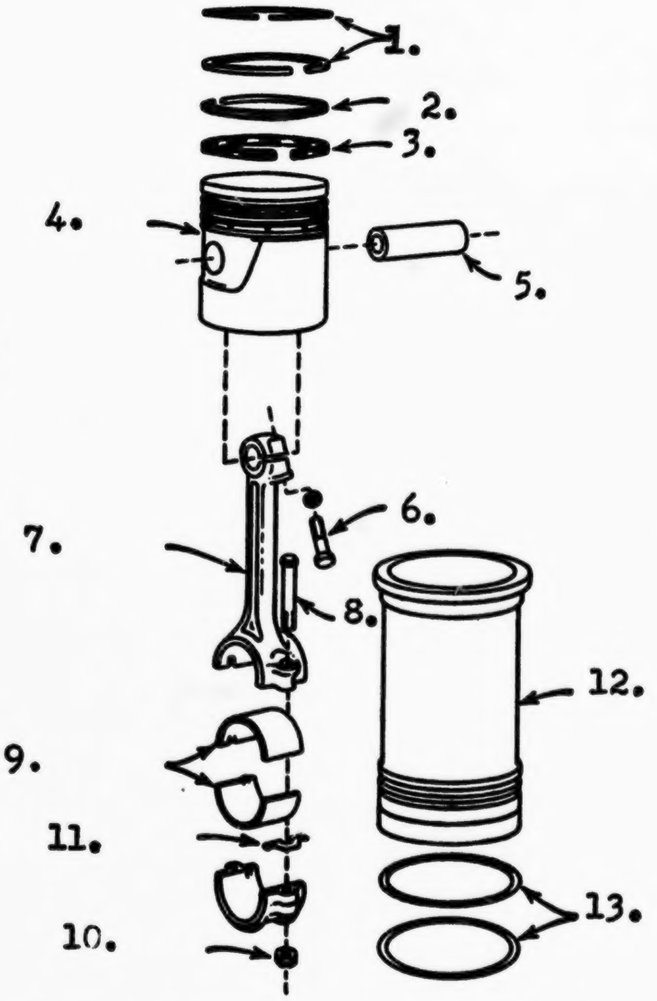
Cylinder head, gasket and related parts (Allis-Chalmers Mfg. Co.)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Piston and parts, connecting rod and bearings, cylinder liner (Allis-Chalmers Mfg. Co.).

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910-II-5

Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Internal Combustion Engines

TOPIC: Power Plant Disassemble, Assemble and Repair

OBJECTIVE: To develop an understanding of the procedure to follow in disassembling an engine, checking for items in need of repair and assembling the engine.

INTRODUCTION: Do you know the proper sequence to follow in disassembling and assembling an engine? Often times labor is wasted because someone will try to disassemble an engine and not know the proper order to follow. They will try to remove a part which cannot be removed until something else is first removed. This assignment will cover a lot of territory however it is felt necessary to include this one lesson in order to give a complete logical sequence to follow in working on engines. As we study this lesson both carburetor and diesel engines will be considered. It must be kept in mind that no one procedure will fit every brand of engine therefore, when working on a specific brand always use the repair manual for that brand.

REFERENCES: Required:

1. "Dealers Repair Manual".
2. Information Sheet, "Power Plant Disassemble, Assemble and Repair".

Supplemental:

3. Farm Gas Engines and Tractors, Jones, Ch. 7.

QUESTIONS or ACTIVITIES:

1. What is the best way to clean an engine in preparation for overhauling it?
2. What five major steps are necessary in preparing an engine for an overhaul job?

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3. What two additional parts must be removed from a diesel engine?

4. As a person disassembles an engine what are some important points that he should look for when determining if the engine should be completely overhauled or not?

5. How can a starter ring gear be removed from the flywheel?

6. When removing any bearing cap, rod cap or two pieces of metal that must be fitted together, how can these be marked so that you may be sure to replace them exactly as they were removed?

7. What engine parts assure good oil pressure?

8. When torqueing down bolts how many pounds of torque should be increased each time?

9. What is end ring clearance?

10. How should the rings be installed on the piston?

11. When installing pistons which way should the notch or arrow on the piston top point?

12. In what order are the cylinders of an engine numbered?

13. How may a generator be checked for proper working order?

14. How may a thermostat be checked for proper operation?

15. How is the thermostat properly installed?

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Information Sheet
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POWER PLANT DISASSEMBLE, ASSEMBLE AND REPAIR

Thorough cleaning is the first step in preparing an engine for overhaul. The best method is steam cleaning; but if this is not possible, clean the engine with a mixture of one part "Gunk" concentrate (a cleaning compound made for dirty engines) with four parts kerosene. Paint the engine with this mixture and allow it to soak for 20 minutes; then wash it off with a spray of water.

After the engine has been thoroughly cleaned, follow these steps to prepare it for overhaul:

1. Remove engine accessories. These include the hood, shrouds, radiator shell and grill.

2. Drain the coolant from radiator and block into a clean container and inspect it for rust particles and other foreign particles.

3. Remove all radiator clamps and hoses, noting those that need to be replaced. Record this information on the reconditioning sheet.

4. Remove the radiator holding bolts and the radiator.

    a. Check the radiator for bent fins, external leakage, and corrosion build up inside the radiator.

    b. If the radiator needs repair, send it to a radiator shop.

5. Remove external engine parts.

    a. Battery clamp and battery

        (1) Remove battery cables removing the ground cable first.
        (2) Inspect cables and note condition.
        (3) Using a hydrometer and voltmeter, test the battery and recharge it, if necessary.

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b. Starter

c. Water manifold and thermostat

    (1) Check thermostat and note its condition.

d. Carburetor (gasoline engine only)

    (1) Remove linkage.
    (2) Turn valve on gas tank off and remove gas line.
    (3) Remove air cleaner base and note its condition.

e. Governor

Diesel engines do not have the same type of governor as gasoline engines. Omit this step on the diesel engine.

    (1) Disconnect linkage and oil line.
    (2) Remove bolts around the housing.
    (3) Slip governor unit from housing.
    (4) Check spring for tension.

f. Intake and exhaust manifold

g. Air cleaner

    (1) Check condition of air cleaner. An excessively dirty cleaner may suggest possible clues to causes of internal malfunctions.

h. Spark wires, spark plugs, and distributor

A diesel engine has a different type of fuel and ignition system. The following procedures should be followed when removing the injector and injector pump.

1. Injector

    a. Turn fuel valve off at tank.

    b. Remove fuel lines from injectors.

        (1) All fuel lines from pump to injectors must be removed at each end.

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(2) Remove line bracket.
(3) Be careful not to bend lines.

c. Remove injector

(1) Remove hold-down nuts.
(2) Use crowfoot bar to pry injector out.
(3) Remove injector, being careful not to bump the nozzle tips.
(4) Wrap injector in a soft cloth to avoid damage to the nozzle tips while they are out of the engine. Always remove the injector before removing the head.

2. Injection pump

a. Locate marks used in timing pump.

b. Rotate engine until marks are in proper position and the number one cylinder is on the compression stroke.

c. Remove throttle and stop linkage attached to pump.

d. Remove fuel lines.

e. Remove primary fuel line from pump.

f. Remove bolts holding the pump to the block.

g. Remove oil line that runs from the pump to block.

h. Remove pump.

i. Any calibration of the pump must be made on a test stand. Most dealers do not do this job but send pumps to special diesel repair shops. Some pumps, however, may be calibrated on the engine, operating at maximum load and using a ball fuel meter or dynamometer to measure fuel consumption.

j. Three types of injection pumps have been developed for use on diesel engines.

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(1) Roosa master
(2) Boash
(3) Simms

Manufacturer's specifications should be followed when overhauling these pumps.

k. Clean injection pump screen which is located on head of pump.

(1) Remove plug.
(2) Remove screen and "o" ring.
(3) Wash in solvent and blow dry with compression.
(4) Install screen on plug and ring.
(5) Install injection pump in head.

After thorough testing and removal of all accessories and external parts, the engine is ready to be overhauled. A mechanic should learn well the following procedure, which outlines a complete engine overhaul, before he accepts employment and proceeds to overhaul a tractor engine in an agricultural machinery dealership.

Disassemble the engine in the following manner, and make observations of worn parts, and other faults.

1. Valve cover

   a. Remove valve cover by taking out four attachment bolts. Make sure that the area around the cover is clean and dirt free before the cover is removed.

2. Rocker arm assembly

   a. Oil must flow to the rocke[illegible] assembly through an oil line or stud which retains this assemble. Locate the flow openings and check to see if they are plugged.

   b. Remove the oil line.

3. Push rods

4. Head nuts or capscrews

These are special nuts or capscrews of high strength steel. Under no circumstances should nuts or capscrews of any other material be used for this purpose.

5. Remove head

   a. Visually inspect the head, noting the following:

      (1) Condition of valves
      (2) Condition of headgasket
      (3) Condition of top of piston

         (a) Excessive carbon indicates bad rings.
         (b) Piston loose in cylinder

      (4) Pitting in the piston top and cylinder wall

         Pitting is caused by water entering the combustion chamber through the head gasket or a crack in the head or sleeve.

      (5) Taper of the cylinder wall

         The taper of the cylinder is checked by a dial indicator or inside micrometer. Measure the diameter of the cylinder where the top ring travels and above the piston when at bottom dead center. By subtracting the latter measurement from the former the amount of taper can be determined. Compare the taper with maximum taper given in the manufacturer's specifications for the tractor.

      (6) Check cylinder for being out of round.

         To check a cylinder for being "out of round," use the same tools as those used to check taper.

6. Remove valves from head and determine condition.

   a. Place head on work lead.

   b. Using suitable valve compressor, compress spring and cap and remove the two locks located on the end of the valve stem.

c. Release valve compressor.

d. Remove spring and valve cap. Some engines may have rotating valve caps on the exhaust valves. These caps allow valves to rotate, thus keeping the seat clean and free of carbon. Also, some engines may be equipped with two valve springs on each valve, allowing more positive valve seating.

e. Remove valves.

   (1) Visually inspect each valve for excessive burning.
   (2) Check valve stem for sticking in the guide, which is caused by carbon in the guide. The guide should be cleaned or replaced.
   (3) Check the valve seat for burning or cracks.

At this point in the overhaul procedure, study all observations made to determine whether a complete overhaul is necessary or whether reconditioning of the valves would bring the compression back to within manufacturer's recommendations. If the tractor needs a complete overhaul, follow these procedures:

1. Remove the engine block from the tractor mounting.

   a. Drain oil from the oil pan by removing the plug in the bottom of the pan.

   b. If necessary, remove the front axle and axle support, which is bolted to the engine block.

      (1) Disconnect the front axle wishbone supports and steering linkage.
      (2) Place safety jack under the transmission to support the engine while removing the front axle and wheels.
      (3) Remove bolts around the rear engine bell housing. Usually there are one or two line-up pins in the rear bell housing which often stick and need to be freed by prying the engine away from the transmission.

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   c. Attach engine lifting straps to the block so that when the engine is lifted from the mountings it will be balanced. Use short capscrews to replace the head studs or capscrews.

   d. Hook sound chain falls on hydraulic lifting crane to engine strap and remove the engine block from its mountings.

2. Place engine on an engine stand and fasten it down tightly, If an engine stand is not available, lay the engine block on its side on a workbench.

3. Remove oil pan.

   Take off capscrews around the oil pan, and check it for sludge deposits in the bottom.

4. Remove oil pump.

   a. Remove oil pump screen and pick-up tube. In some cases this tube may be a part of the pump.

   b. Remove locks on safety wire from the capscrews or nuts which hold the oil pump in place.

   c. Turn the pump housing back and forth until it comes free.

5. Remove fly wheel.

   a. Remove pressure plate.

      (1) Remove capscrews on the pressure plate evenly.
      (2) Be prepared to catch the pressure plate and clutch disk, as they drop when the last capscrew is removed.

   b. Remove flywheel nut locks and nuts

      (1) It may be necessary to lay a 2" x 4" block of wood, 12" long, beside the crankshaft to keep the crandshaft from turning during removal of flywheel nuts.

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(2) Tap flywheel off with a soft mallet hammer.
(3) Because of the weight of the flywheel, be careful not to drop it while removing from the engine.

6. Check the flywheel starter ring gear for missing teeth and slippage on the flywheel, and record findings.

   a. Remove ring gear from the flywheel, cutting halfway through the ring gear with a cutting torch and splitting the remainder with a chisel, or cutting halfway through with a 1/4" drill and splitting the remainder with a chisel.

      Be extremely cautious to avoid cutting with the torch or drilling into the flywheel.

   b. Install new ring gear.

      (1) Lay ring gear on flat fire bricks that completely support it.
      (2) Use a torch to heat ring gear to 360° or until it turns a dark straw color.
      (3) Quickly place ring gear on flywheel and let cool into place.

7. Remove pistons.

   a. On engines with sleeves, install a short capscrew and large washer at the top of each sleeve to hold sleeve while removing piston.

   b. Cut ridge frame cylinder with a suitable ridge removing tool. Follow manufacturer's instructions for using the tool to remove the cylinder ridge.

   c. Rotate crankshaft until the number one piston is at the bottom of its stroke.

   d. Remove lock nuts on cotter pins from connecting rod.

   e. Mark rod cap with a center punch on both halves to make certain it is reinstalled in the same position it was before disassembly. Also, noticewhether mark is on the crankshaft side, and record observation.

f. Remove connecting rod nuts.

g. Remove rod cap.

(1) Inspect insert for excessive wear, pitting, and corrosion.
(2) Remove upper insert bearing.

h. Push piston out of cylinder.

i. Throw inserts away and reinstall cap on rod.

j. Repeat steps a through i to remove the remaining pistons.

8. Inspect piston, pins, and connecting rods.

a. Clean piston.

(1) Remove old rings.
(2) Remove carbon from the piston top with a scraper.
(3) Remove carbon from ring bands with a broken ring.
(4) Do not use a wire brush for cleaning these parts.
(5) Clean oil groove and oil return holes. The oil return holes should be cleaned with a drill bit of the same size as the oil return holes so as not to enlarge the holes.
(6) Using a micrometer, check the size of the pistons against manufacturer's specifications, and determine whether they are within limits. A micrometer check also reveals whether the pistons are standard or oversized.
(7) Compare the ring band of piston with that of a new ring and check it with a feeler gauge. Insert ring in groove. Check the distance between the ring edge and groove wall. Check size of gap with manufacturer's specifications for maximum allowance clearance. These measurements, along with visual inspection and piston size, indicate whether the piston should be replaced.

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b. Inspect connecting rod.

Put the connecting rod cap in place on the rod with punch marks lined up and rod nuts torqued to manufacturer's specifications. Using an inside micrometer, check whether the inside of the rod is out-of-round and the connecting rod opening is within manufacturer's specifications. If the measurements are not within specifications, install a new rod or recondition the old rod at a machine shop.

c. Check wrist pin.

(1) Remove wrist pin from rod.

(a) Mark piston and rod with a center punch to make sure they are reinstalled in the same position they were before disassembly.
(b) Remove snap rings on lock bolts that retain pin in the piston.
(c) Using a brass punch, drive the pin out of the rod. Some pistons require that the wrist pin be pressed out. This is a job for a machinist who has a special piston holder and press.

(2) Using a micrometer, check pin to see whether it is within manufacturer's specifications.
(3) Check inside of the rod bushing with a telescopic gauge and outside micrometer to determine whether the opening is within manufacturer's specifications.
(4) Record all measurements in order to determine what parts should be replaced or reconditioned.

9. Check cylinder for taper and being out-of- round.

These checks are made with an inside micrometer or dial indicator. If the taper is not within specifications or the cylinder is out-of-round, install new sleeves or rebore the cylinders.

10. Remove crankshaft.

a. Before removing crankshaft, check end play. One bearing,

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usually the center or rear bearing, controls the end play with a thrust ring built on the insert or a separate ring. Locate the thrust bearing, and pry crankshaft forward. Insert feeler gauge in the opposite side and measure the gap. Record the gap and check it against manufacturer's specifications. If a new bearing is needed, it may be obtained in oversize thrust to take up for wear on the crankshaft flange.

b. Remove front crankshaft pulley.

    (1) Remove set screw, nut, or retaining bolt from the pulley.
    (2) Using a suitable puller, remove crankshaft pulley.
    (3) Be careful to fit puller jaws on the solid part of the pulley.
    (4) Check pulley for cracks and excessive wear on the sealed surface.

c. Remove timing cover.

    (1) Remove all capscrews and nuts on the retaining cover.
    (2) Pry cover off.
    (3) Notice if the crankshaft end-play adjusting setscrew is built into the retaining cover.

d. Check backlash between camshaft and crankshaft gear with dial indicator.

    (1) Mount dial indicator on front of engine with needle resting on camshaft gear teeth.
    (2) Rotate camshaft back and forth without moving the crankshaft. Take dial reading and compare with manufacturer's specifications listed as camshaft gear backlash. If backlash is excessive, new gears are needed.

e. Check timing marks on the camshaft and crankshaft gears. The marks must line up before disassembly and at reinstallation.

f. Mark main bearing cap in relation to block. Be careful to put caps back in the same position and place when reinstalling them.

g. Remove main bearing capscrew or nuts. Some nuts or capscrews have locks, and others are self-locking.

h. Remove main bearing cap by tapping it with a soft mallet hammer. Inspect the insert bearing for pitting, grooving, and excessive wear. At this point it may be necessary to remove the rear main oil seal retainer and seal.

i. Remove crankshaft. Try to keep it standing on end to avoid possible warping.

j. Reinstall main caps on block and tighten them to prevent damage to the caps.

11. Check the crankshaft.

a. Using a micrometer, check each journal for the following:

(1) Out-of-round condition
(2) Excessive wear
(3) Taper of journal

Micrometer readings should be recorded and compared with manufacturer's specifications.

b. Check rear oil seal surface.

c. Check straightness of crankshaft.

(1) Using two "V" blocks, rest the number one journal on one block and the rear main journal on the other block.
(2) Set dial indicator needle to ride against the center main bearing and rotate shaft. Record the dial reading. If the reading is excessively high, a new crankshaft or regrinding of the old one, is needed. Compare the dial readings with the manufacturer's specifications to determine whether to replace, regrind, or reuse the crankshaft.

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12. Remove cylinder sleeves.

    a. Use a suitable puller to pull sleeves out of the block. Sometimes wet sleeves may be driven out of the block with a hard wood block.

    b. Remove the capscrews that hold the sleeve in place. If the engine does not have sleeves, have the cylinder rebored at a local machine shop.

13. Remove camshaft.

    a. Remove retaining bolts behind cam gear.

    b. Slip camshaft out of the block. It is not necessary to remove the gear from the camshaft unless the gear needs replacing, in which case it must be done in a press.

    c. Be careful not to let the camshaft lobes scrape on the cam bushing when slipping it out of the block.

    d. Check camshaft with a micrometer to determine the bearing journal and lobe sizes, and compare these measurements with the manufacturer's specifications.

14. Remove valve lifters and check them for excessive wear and pits in the flat surfaces.

15. Remove camshaft bushing.

    a. Use a suitable driver plug fitted to the cam bushing and drive out all bushings.

    b. Camshaft bushings, the heart of good oil pressure, should be replaced on all overhauls.

16. Clean engine block.

    a. Soak block in cleaner tank and wash with hot water.

       Blow out all oil passages with air. If steam cleaner is available, steam the block and force steam through the oil passages.

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b. The block should be cleaned after the cylinders have been rebored.

c. Using 80 grit sandpaper, sand the top of the block and the base where the sleeves are installed. Caution: the cylinder must be clean around the top flange and at the bottom where the "O" rings seal.

d. Check block for cracks.

Up to this point in the overhaul procedure, disassembly of the engine and inspection of its parts, has been emphasized. The emphasis now turns to the installation of new parts and reassembly of the engine. The following procedure should be followed in reassembling the engine and installing parts:

1. Install camshaft bushings.

    a. Coat the surface of the bushings with light number 10 oil and install them in the block with a driving plug.

    b. Make sure that the oil holes in the bushing align with the oil holes in the block.

2. Install cylinder sleeves.

    a. Before installing "O" rings on the sleeve or in the block, try each sleeve in the block to make sure it falls into place without having to be forced.

    b. Install "O" rings on sleeve or in the block, using the lubricant recommended by the manufacturer.

    c. Push sleeve into place with hand or a light tap of a soft mallet hammer.

    d. Check protrusion of sleeve above block to make sure that it comes within the manufacturer's specifications. Shims may be added under sleeve flange to increase the protrusion.

3. Coat valve lifters with number 30-weight oil and install them in the block.

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4. Install camshaft.
    - a. Coat bearings with number 30-weight oil.
    - b. Slide the camshaft through each bearing. Do not let lobes slide on the bushings.
    - c. Check for free rotation of the camshaft. If it does not rotate freely, the bushings have been improperly installed.
    - d. Install camshaft retaining bolts, and check end play of shaft with dial indicator to compare with manufacturer's specifications.

5. Install crankshaft.
    - a. Remove main cap.
    - b. Install new bearing inserts in the block and cap. Make certain that the two bearing halves are installed opposite each other.
    - c. Coat bearing with 30-weight oil.
    - d. It may be necessary to install one-half of the rear main oil seal.
        - (1) Coat back of seal with aviation sealer.
        - (2) Soak inside with 30-weight oil.
        - (3) Push into channel.
    - e. Place crankshaft in the block. Make certain that the camshaft and crankshaft gear timing marks are in line.
    - f. Install main bearing caps.
        - (1) Place plastic gauge strip on the bearing and install the cap.
        - (2) Align marks on caps with marks on the block.
        - (3) Install main bearing bolts and locks.
        - (4) Torque bolts down, 20 pounds at a time, to manufacturer's specifications.

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(5) Remove cap and read plastic gauge on the bearing. This indicates the bearing clearance. If too much clearance is read, oversized bearings are needed.

g. Check crankshaft end-play.

6. Install front timing cover.

a. Install front crankshaft seal in cover.

(1) Coat outside of seal with aviation sealer.
(2) Coat inside with number 30-weight oil.
(3) Tighten all bolts uniformly.

7. Install crankshaft pulley.

a. Coat pulley seal surface with 30-weight oil.

b. Make sure inside of pulley is clean. If it is not, use sandpaper to clean and clear it.

c. Use a block of wood and hammer to tap the pulley into the crankshaft and install retainer.

8. Install pistons on connecting rod.

a. Read manufacturer's instructions for installing rings.

b. Check rings for size.

(1) Insert rings in cylinder and measure end gap with feeler gauge. All rings except the oil rings, must be checked.
(2) Check manufacturer's specifications to be within clearance limits. If ring end clearance is inadequate, it should be filed.

c. Check piston cylinder clearance.

Insert piston into cylinder and check side clearance to be within manufacturer's specifications.

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d. Assemble connecting rod and piston.

(1) Have the pin and bushing fitted at a machine shop that has honing and aligning equipment.
(2) Install piston and rod together, making sure the mark on top of the piston is toward the front of the engine and the mark on the rod is in proper relation to the camshaft.
(3) Install locks on pins.
(4) Caution: follow manufacturer's guide for locating piston to rod alignment.

9. Install piston and connecting rod in the sleeve.

a. Install rings on the piston with a recommended ring expander.

(1) Carefully place each ring on the piston with the top marking up.
(2) Make sure rings are in the right grooves.
(3) Follow ring manufacturer's specifications for installing rings on piston.

Example: (a) Oil ring should be installed in the bottom groove with the level toward the top.
(b) The scraper ring must be installed in the second groove with the outside notch down.
(c) The compression ring must be installed in the top piston groove with the inside notch up.

b. Remove rod cap.

c. Cover piston and rings with number 30-weight oil.

d. Place ring compressor around piston and compress rings. Note: Follow the manufacturer's specifications for the type of compressing tool to use.

e. Slide skirt of piston into sleeve, making sure the notch or arrow is toward the front of the block.

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f. Tap piston into sleeve with hammer handle. Only light pressure is needed to force the piston out of the ring compressor. Make sure the connecting rod aligns with the crankshaft as the piston is tapped into the cylinder. Be careful not to scratch the crankshaft journals.

g. Install rod bearing and check.

(1) Coat the upper half of the bearing insert with 30-weight oil and insert in the connecting rod.
(2) Push connecting rod with piston attached down onto crankshaft.
(3) Install lower half of bearing insert into the cap and cover with oil.
(4) Place a strip of plastic gauze on the insert in the cap.
(5) Install cap on connecting rod.
(6) Tighten rod bolts or nuts according to manufacturer's specifications.
(7) Remove rod bolts or nuts and read the plastic gauge. Compare these clearance readings with the manufacturer's specifications. If the clearance is greater than those prescribed by the manufacturer, use oversized bearings and repeat steps five and six.
(8) Install lock nuts and bend metal locks around nuts.
(9) This procedure should be used when installing all rod bearings.

10. Overhaul and install the oil pump.

a. Disassemble oil pump.

(1) Remove gear from pump, using suitable puller.
(2) Remove all parts from pump and clean them thoroughly.
(3) One should install an oil pump overhaul kit, which includes new gears, shaft, gasket, and pressure regulating valve, when overhauling an oil pump.
(4) Install new pump parts.

(a) Check backlash between gears.

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        - (b) Check gear-to-housing clearance.
        - (c) Check gear end clearance.
        - (d) Compare these findings with manufacturer's specifications. If the readings are higher than those set down in the manufacturer's specifications, replace the housing.

    - (5) Install pump into the block, torque bolts to manufacturer's specifications, and lock with wire or metal locks.
    - (6) Fill oil pump inlet tube with number 30-weight oil to aid in priming the pump.

11. Install oil pan.

    a. Coat block with aviation sealer and stick gasket to it.

    b. Install pan and tighten bolts. Do not tighten bolts too tight, as they will break the gasket.

12. Recondition cylinder head.

    a. Clean head.

        (1) Using a 1/4 hp. drill with a wire brush, remove carbon from the head.
        (2) Use a carbon scraper to remove excess carbon that cannot be removed with a wire buffer.
        (3) Clean around valve seats.
        (4) Wash the head in a cleaning solution and then hot water.

    b. Remove and replace valve guides.

        (1) Drive guides out of head with a suitable guide driver and hammer.
        (2) Using emery paper, clean hole in head where guides are inserted.
        (3) Wipe guides and blow area around guide holes clean with compressed air.
        (4) Coat guide with number 10-weight oil and drive in place with driver and hammer.

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(5) Follow manufacturer's specifications for length of guide protrusion.

c. Grind valve seats.

(1) Select valve guide pilot to fit guide.
(2) Select a stone to fit the valve seat outside diameter and the degree of angle on the seat.
(3) Set grinder on the seat and reface the seat.

(a) Make sure the seat is within allowable limits for width of seat.
(b) If the seat is too wide, use a 15° and 75° stone to narrow the seat.

d. Using a straight edge, check the head for warp.

e. Reface valves.

(1) Clean valves with wire brush.
(2) Using a micrometer, measure the valve stem for comparison with the manufacturer's specifications.
(3) Set valve grinding machine for proper valve face angle.
(4) Reface all valves.

Check valve head thickness after grinding to be certain it is within manufacturer's specifications.

(5) Resurface valve stems on grinding machine.
(6) Place valve in the head and check margin of seat on valve face with bluing. Grind seat to bring it within manufacturer's specifications, and allow proper valve seating.
(7) Check valve springs.

(a) Using a valve spring tester, check spring length and the tension at a given length.
(b) Compare these measurements with the manufacturer's specifications and replace valve springs not within manufacturer's limits.

(8) Coat valves and stems with number 30-weight oil and place in the head.

(9) Install valve spring and keeper.

- (a) Check valve spring to see if there is any difference in the top and bottoom by check-for coils being close together.
- (b) Install valve seals on stem of valve if recommended by the manufacturer.

f. Clean and check energy cells.

Note: Some diesel engines use what is called an "energy cell" or "precombustion chamber" to increase combustion efficiency.

(1) Remove cell from head.

- (a) Remove bolts from cell.
- (b) Remove bolts from cell hold-down bars.
- (c) Remove bars and caps.
- (d) Remove cell with the necessary special puller and slide hammer, and check for burnt tips and enlarged hole. Keep all cells and caps together.
- (e) Soak cell in carbon remover, wash, and blow dry with compressed air.
- (f) Lap the cap and cell on a special lapping tool.
- (g) Clean hole in head and check for burnt places where cell may leak. If the cell has been leaking, replace the compression.
- (h) Replace any burnt cell.
- (i) Assemble and install in reverse order, following the procedure outlined by the manufacturer.
- (j) Torque nuts and hold-down bar to manufacturer's specifications.

13. Install head on block.

a. Install a new head gasket.

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- b. Coat gasket with a recommended gasket sealer.
- c. Install all head bolts and snug them down.
- d. Use torque wrench to finish tightening head bolts. Follow manufacturer's sequence for torquing head bolts.

14. Install push rods.

    Make certain that each rod is set in the valve-lifter socket.

15. Recondition rocker arm assembly.

    - a. Remove all arms from shaft.
        - (1) Remove cotter pin and washer.
        - (2) Note where oil holes are in respect to the shaft.
    - b. Resurface all rocker arms on valve refacing machine.
    - c. Check rocker arm shaft with micrometer for excessive wear and compare with manufacturer's specifications.
    - d. Clean shaft internally to keep sludge from plugging oil holes.
    - e. Assemble rocker arms and shaft.

16. Install rocker arm assembly on head.

    - a. Fit all rocker arm balls into socket of push rod.
    - b. Make sure oil feed stud on line is in the proper place.
    - c. Back up adjusting screws.
    - d. Tighten rocker arm assembly to head.

Power Plant Disassemble, Assemble and Repair
(Information Sheet continued)

17. Adjust valves.

    They should always be adjusted cold before starting engine.

18. Install valve cover.

    Coat valve cover with sealer and stick gasket to it. Do not coat the other side of the cover gasket.

19. Overhaul and install distributor (gasoling tractor only).

    a. Remove distributor cap.

        (1) Check for cracks, corrosion on points, and other signs of wear.
        (2) Remove rotor and inspect.

    b. Remove points.

        Check conditions of points.

    c. Remove condensor.

        Test condensor on tester.

    d. Remove point plate.

    e. Check spark advance weights for sticking.

    f. Check spark advance spring tension.

    g. Check distributor shaft and bushing for excessive wear.

    h. Assemble in reverse order.

    i. Lubricate advance weights with number 10-weight oil.

    j. Install new points and condensor.

    k. Adjust the distributor to the manufacturer's specifications on high cam and lubricate cam with distributor cam grease.

Power Plant Disassemble, Assemble and Repair
(Information Sheet continued)

1. Install rotor and cap.

20. Install and time distributor.

21. Install spark plug wires.

    a. Check spark plug wires for cracks and bad insulation.

    b. Check terminals, making certain that they fit tight in the distributor cap and on the spark plug.

    c. Check the spark plug firing order.

        (1) Remove the spark plug in the number one cylinder
        (2) Rotate crankshaft until the number one piston is almost at the top of the compression stroke.
        (3) Insert spark plug.
        (4) Install the wire on the spark plug and in the distributor cap wire plug opening which the rotor in the distributor points to.
        (5) Install the remaining wires in rotation, running them to the plugs according to the firing order.
        (6) The cylinders are numbered starting with the first cylinder, which is the closest to the radiator, and counting back.

22. Install injector pump (diesel tractor only).

    a. Rotate engine to bring the number one cylinder to the top of its compression stroke.

    b. Line up crankshaft pulley on flywheel timing marks.

    c. Turn the injector pump to proper timing mark and slide it into the block, meshing the gear on the pump with the gears on the crankshaft.

    d. Recheck alignment of all markings.

    e. Reassemble all parts in the reverse order.

Power Plant Disassemble, Assemble and Repair
(Information Sheet continued)

23. Overhaul and install water pump.

    a. Remove fan from the pump.

    b. Remove fan hub and pulley with a pulley puller and mark the position of the hub on the shaft.

    c. Remove rear pump cover.

    d. Remove pump impeller from shaft.

    e. Remove seal assembly.

    f. Remove snap ring and then shaft and bearing from the pump housing.

    g. Clean housing with a scraper and sand paper and blow clean with compressed air.

    h. Install new water pump kit.

        (1) Using soft hammer, tap shaft and bearing into housing, and install snap ring.
        (2) Install new seal in the pump impeller.
        (3) Press impeller into place on the shaft. Do not tap on the shaft or seal, as it will break the seal.
        (4) Press fan hub onto shaft in its original position.
        (5) Install gasket and rear pump cover.
        (6) Install a new pump gasket.
        (7) Install pump on engine.

24. Overhaul and install generator.

    a. Overhaul generator.

        (1) Remove and inspect generator cover.
        (2) Remove terminal wire from armature brush holder
        (3) Remove wire from field to armature brush.
        (4) Remove long bolts from the commutator end-frame, and remove frame and generator brushes.
        (5) Remove field housing from pulley end-frame, Remove the pulley by removing the attachment nut and pressing the shaft from the pulley.

Power Plant Disassemble, Assemble and Repair
(Information Sheet continued)

- (6) Remove pulley key and top armature shaft from the bearing.
- (7) Remove bearing from frame and check, clean, and repack it with grease. Clean generator parts in cleaning solution, wash with water, and blow dry with air under low pressure.
- (8) Check commutator end-frame bushing and armature shaft for excessive wear. Replace bushing, if necessary.
- (9) Check armature

    - (a) Grawler test
    - (b) Induction test
    - (c) Light short test

- (10) Check field coil.

    - (a) Light continuity test
    - (b) Light short test

- (11) Turn commutator on metal turning lathe and undercut mica. Smooth commutator with fine sandpaper.
- (12) Install new brushes and make certain they fit properly against the commutator.
- (13) Assemble the generator, reversing the disassembly order outlined above.

b. Install generator on engine.

- (1) Install new fan belt and tighten.
- (2) Polorize generator.

25. Overhaul and install starter.

a. Remove starter and inspect its parts.

b. Remove screws holding field wires to brush holders.

c. Remove end-frame bolts and frame. Center punch housing for use in aligning the frame and housing.

Power Plant Disassemble, Assemble and Repair
(Information Sheet continued)

- d. Remove bolts from drive-end frame and remove the frame.
- e. Remove armature from field housing.
- f. Remove and inspect drive mechanism.
    - (1) Check for broken spring.
    - (2) Check for sheared drive bolt.
    - (3) Check for untrue gear teeth.
    - (4) Check for sticking screw mechanism caused by heavy grease, oil, or rust.
    - (5) Clean parts, install new parts, as needed, and lubricate with 10-weight or a lighter oil.
- g. Check field coils.
    - (1) Use light test for continuity.
    - (2) Use light test for detecting a short.
- h. Check armature.
    - (1) Use grawler test.
    - (2) Use light test for shorts.
    - (3) Use grawler test for induction.
    - (4) Turn commutator on metal lathe. Do not undercut the mica on a starter commutator.
- i. Check end-frame bushing for excessive wear, and replace if necessary.
- j. Check armature lamination for wear, which would suggest worn bushings.
- k. Seat new bushings on commutator.
- l. Reassemble starter, and install on the engine.

26. Install water manifold.
    - a. Check thermostat.
        - (1) Place the thermostat in a pan of water.

Power Plant Disassemble, Assemble and Repair
(Information Sheet continued)

(2) Heat the water with a torch.
(3) Note the temperature of the water when the thermostat opens.
(4) Check this temperature reading with the manufacturer's specifications for temperature at which the thermostat should open. If the thermostat does not open within manufacturer's specifications, replace it with a new one.

b. Install thermostat in the head, with coil toward the block.

c. Install water manifold gasket and water manifold on the head.

27. Install intake and exhaust manifold.

a. Scrape and sand head and manifold gasket surfaces.

b. Install gasket on head.

c. Install manifold.

d. Torque bolts uniformly to meet manufacturer's specifications.

27A. On diesel engines the manifold heater must be cleaned and adjusted at this stage in the overhaul procedure.

a. Remove heater from manifold.

b. Check for burnt insulator material that may be shorting heater element.

c. Check insulated bolts.

d. Check element for burnt spots.

e. Check element for proper ground.

f. Reassemble element and install in the manifold.

g. Test the heater element.

(1) Connect manifold to the positive post of a 1250 battery.
(2) Connect insulated terminal to negative post. Wait 60 seconds and check the element. It should be red hot.

Power Plant Disassemble, Assemble and Repair
(Information Sheet continued)

28. Overhaul and install fuel injectors (diesel only).

a. Remove injectors and attach to pump injector tester.

(1) Note pressure build-up until the injector injects fuel.
(2) Keep hands away from the injector nozzle, as the fuel is under high enough pressure to penetrate the skin.
(3) Watch spray pattern.
(4) Check injector to see if it will hold pressure to within 300 lbs. of pop-off without leaking at tip.

b. Clean injector.

(1) The injector should be cleaned and reset according to the procedures outlined by the manufacturer.
(2) Cleanliness is of utmost importance here because all parts are built with close tolerance.

c. Install injector after overhauling the engine.

d. Using a piece of dowl stick wrapped in a soft cloth, wipe the injector hole clean.

e. Place a new copper gasket on the injector and install the injector in the head.

f. Tighten the injector hold-down nuts uniformly, according to manufacturer's specifications.

g. Install fuel lines.

Note: The following procedure should be carried out after the fuel filters are cleaned.

h. Bleed injector.

(1) Loosen all injector lines at the injector and set the throttle to start.
(2) Crank engine until fuel leaks from lines.
(3) Close all lines and start engine.
(4) Loosening one line at a time, let all air out of the line.

Power Plant Disassemble, Assemble and Repair
(Information Sheet continued)

29. Overhaul and install governor (gasoline tractor only).

    a. Clean governor.

    b. Disassemble unit and check for the following:

        (1) Worn linkage
        (2) Worn weight pins
        (3) Worn and flat spots on weight balls
        (4) Worn bearing, bushing, and shaft
        (5) Worn and broken thrust bearing
        (6) Tension on governor spring

    c. Reassemble entire unit.

    d. Install new gasket, using aviation sealer to seal gasket to housing, and install the governor on the engine.

30. Overhaul and install carburetor.

    a. Disassemble entire carburetor.

        (1) Remove screw around the float, and split carburetor.
        (2) Remove float by slipping pin out of bracket.

            (a) Check float for dents.
            (b) Shake float to see if there is fuel inside it.

        (3) Remove float needle valve assembly, seat, and seat gasket.

            (a) When installing the seat, make sure the new seat gasket is in place.
            (b) Needle, seat, and gasket should always be replaced for good fuel regulation.

        (4) Remove all jets.
        (5) Soak all parts in a carburetor cleaning solution for one hour.
        (6) Wash with hot water, and blow dry with compressed air.

Power Plant Disassemble, Assemble and Repair
(Information Sheet continued)

b. Assemble carburetor.

   (1) Install carburetor overhaul kit.
   (2) Install jets in the lower and upper carburetor housing.
   (3) Install float seat in upper carburetor housing.
   (4) Install float and pin. Adjust float according to manufacturer's specifications.
   (5) Reassemble remaining parts.
   (6) Check choke butterfly to see that the anti-flooding valve is operating properly.
   (7) Preset all outside adjustments to manufacturer's specifications.

c. Install new carburetor flange gasket.

d. Install carburetor on the engine.

e. Start engine and set the carburetor for maximum R. P. M.'s by adjusting the governor spring according to the manufacturer's specifications.

31. Set spark plug gap and install spark plugs.

a. Measure the spark gap with a feeler gauge. Compare this gap with the manufacturer's specifications and adjust with a bending tool.

b. Attach spark plug wires.

32. Install oil filter.

a. Install gasket on oil filter bracket, using aviation sealer and bolt filter to block.

b. Soak oil filter element in either number 10-or number 20-weight oil and install filter in bracket.

33. Remove, clean, and install fuel filters (Diesel tractors only).

a. Remove primary fuel filter element. This is the filter closest to the tank.

Power Plant Disassemble, Assemble and Repair
(Information Sheet continued)

(1) Turn fuel off at tank.
(2) Remove cap screw from top of bracket.
(3) Remove fuel filter cup.
(4) Remove element from filter cup.
(5) Wash filter cup in diesel fuel.
(6) Install new elements in filter cup.
(7) Fill filter cup with clean diesel fuel.
(8) Install filter cup in bracket, and install on the engine.

b. Bleed filter.

(1) Loosen bleed screw on the top of the filter. Turn fuel on and open bleed screw until air bubbles cease.
(2) Tighten bleed screw.

c. Clean secondary filter.

(1) Turn fuel valve off.
(2) Disconnect fuel lines.
(3) Remove filter from bracket.
(4) Remove fuel line fittings from old filter.
(5) Discard old filter.
(6) Reinstall fuel line fittings in new filter, using aviation sealer on fittings.
(7) Reassemble secondary filter.
(8) Turn fuel valve on.
(9) Loosen bleed screw in the top of the filter and let the air out of the filter cup.

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Material for this information sheet was taken from Module No. 16, "Tractor Repair", The Center for Research and Leadership Development in Vocational and Technical Education, The Ohio State University, Columbus, Ohio.

910-III-1a

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Lubricants and Lubricating Systems

TOPIC: Lubricants (Engine oils and their functions)

OBJECTIVE: To develop an understanding of oils and their function in an internal combustion engine.

INTRODUCTION: How long can an engine be run without oil and not harm it? First let's say that it is possible to run an engine without oil for a short period of time however the resulting damage is usually beyond repair. Proper lubrication of a tractor engine is a major factor in its continued efficient operation at low maintenance costs. It is obvious that oil serves as a lubricant to prevent metal to metal contact. Oil also has other equally important functions which are not so obvious but should be equally as well understood by the tractor mechanic. It is generally agreed that crankcase oils perform five major functions in engine lubrication. These are:

1. Lubricate moving parts
2. Assist in cooling
3. Seal the combustion gases in the cylinders
4. Aid in keeping the engine clean
5. Protect against rust and corrosion

In the remainder of this assignment we will attempt to determine what is required of a crankcase oil to perform these functions.

REFERENCES: Required:

1. Gulf Farm Tractor Guide

2. Tractor Maintenance AAAE + VA, pp. 18-21

UNIT: Lubricants and Lubricating System
TOPIC: Lubricants (Engine oils and their functions)
(Assignment Sheet continued)

3. "Farm Tractors - Basic Principles, Operation, and Maintenance", Engineering Bulletin FT, pp. 63-64.

Supplemental:

4. Selecting and Storing Tractor Fuels and Lubricants, pp. 27-39.

QUESTIONS or ACTIVITIES:

1. To lubricate all parts of an engine properly, oil must possess the proper "body". What is meant by "body"?
2. How does body affect lubricating qualities of oil?
3. What is viscosity?
4. How does heat affect viscosity?
5. What causes thickening of oil after long continued use in LP - Gas engines?
6. Even though the same chemical reaction occurs (as in 5 above) in gasoline and diesel engines, why is the same result of thickened oil not apparent?
7. What are the major engine parts which depend almost entirely upon the circulation of oil for cooling?
8. What specifically happens when the circulation of oil through the bearings of an operating engine is interrupted?
9. What is the most important characteristic of an oil if it is to seal properly?
10. How do detergent - dispersant oils keep an engine clean?

UNIT: Lubricants and Lubricating Systems
TOPIC: Lubricants (Engine oils and their functions)
(Assignment Sheet continued)

11. Under what types of operating conditions are detergent - dispersant crankcase oils especially valuable in keeping engines clean?

12. Why does contamination of oil occur more readily under the conditions specified in number 11 above?

13. Why is it that all oils do not prevent rust and corrosion in engines?

14. What happens to oil additives as they perform their functions in an engine?

15. List five specific contaminants which make it more advisable to change oil because of oil contamination rather than because of oil deterioration.

VOCABULARY: The following key words or terms have been used in this assignment and should now be a part of your vocabulary. Explain or define each:

Viscosity
Oxidation
Dilution
Oil contaminants
Detergent - dispersant
Additive

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910-III-1b

Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT:	Lubricants and Lubricating Systems
TOPIC:	Lubricants: Crankcase-Oil Viscosity (Grade) and Crankcase-Oil Type (Service Classification)
OBJECTIVE:	To develop the ability to select the proper oil for a tractor engine.

INTRODUCTION: Just any oil is not good enough. The preceding statement does not refer to brand names but to actual viscosity and type of oil as have been scientifically determined and stamped on the container. On an oil container we will find designations of viscosity (grade), such as SAE 30, SAE 20W, SAE 10W-30 or some other SAE designation. We will also find single or multiple designations of API service classifications (type), for example ML or MS, DG and others, all of which will be studied in this assignment.

The operator's manual is the key to determining the viscosity grade and the crankcase oil type to be used for a specific engine. However, there are other factors to consider which will require knowledge of the grade and classification systems as well as good judgment on the part of the mechanic who may service the tractor or advise the operator as the the characteristics to look for in an oil.

To illustrate this point study the attached table from John Deere Operator's Manual, OM-R39699, 3020 Tractors.

By careful study of the table you will note that AIR TEMPERATURE will determine the oil viscosity (SAE Grade). The other factor, EXPECTED TYPE OF ENGINE SERVICE, will determine the crankcase oil type (API Service Classification) which should be used.

UNIT: Lubricants and Lubricating Systems
TOPIC: Lubricants: Crankcase-Oil Viscosity (Grade) and
Crankcase-Oil Type (Service Classification)
(Assignment Sheet continued)

After studying the introduction to this assignment. by careful reading of the references and answering the following questions, you should have a working knowledge of the factors involved in selecting the proper oil for a tractor engine.

REFERENCES: Required:

1. Selecting and Storing Tractor Fuels and Lubricants, pp. 28-29. 34-36. Questions 1-9; pp. 28-29, 10-12; page 34.
2. Information Sheet on "Oil Grades and Service Classification."

Supplemental:

3. "Farm Tractors-Basic Principles, Operation, and Maintenance " Engineering Bulletin No. FT-53, pp. 64-65, 69.
4. "Gulf Farm Tractor Guide", pp. 16-18.

QUESTIONS or ACTIVITIES:

1. What does SAE mean when used preceding a viscosity grade?
2. A lower viscosity grade number indicates that the oil is more fluid or less fluid?
3. What does the "W" indicate which follows the SAE number of the lower viscosity numbers?
4. What single-viscosity grades are available at the present time?
5. Why do viscosity recommendations issued by a tractor company vary with different types, sizes and models of tractors. as well as for different temperature operating conditions?

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Information Sheet
on
LUBRICANTS AND LUBRICATING SYSTEMS

Gear oils are primarily used in the transmissions and rear-axle housings of agricultural machinery. In many respects they are similar to heavy crankcase oils, but their functions are somewhat different. They are given different viscosity-grade numbers (SAE: 80, 90, and 140) and different API classifications to prevent their being confused with crankcase oils.

As tractor horsepower has increased, gears have been improved to meet increased pressure and greater work loads. Gears have become smaller and tooth pressure has increased. In addition to the rolling action which occurs between gear teeth, gears go through a wiping action that tends to wipe away the oil layer separating the two gear surfaces. Additives have been added to gear oils to meet the more severe operating conditions now encountered and to cut down on the wear of gears caused by these increasingly severe operating conditions.

Temperature affects the viscosity of gear oils in the same manner that it affects crankcase oils, Therefore, it is necessary to consider viscosity grade and type classification when selecting gear oils.

1. Gear oil of proper viscosity has enough body to hold moving surfaces apart.
2. If gear oil is too heavy, engine power is wasted; the oil may channel and provide little or no lubrication thus making gears very hard to shift.
3. If the gear oil is too light, the oil film becomes so thin that high points on the sliding surfaces contact and wear rapidly.

Gear oils, like crankcase oils, contain certain kinds of additives depending upon their service classification. These additives include:

1. Anti-oxidants
2. Rust preventatives
3. Foam inhibitors

Lubricants and Lubricating Systems
(Information Sheet continued)

Lubricating grease is basically a lubricating oil with a soap-type thickening agent added to give it consistency. Different types of grease are used on agricultural machinery as determined by the operating requirements of a particular piece of equipment.

1. Lime soap is used in chassis grease; this results in a water-resistant grease that can be used anywhere where high operating temperatures are not present.

2. Soda soap is used to form a semi-smooth grease and is often referred to as wheel-bearing grease.

3. Lithium soap combines the water resistance and heat resistance of the other greases to provide a multipurpose lubricant that is suitable for all-round use on farm machinery.

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Material for this Information Sheet was taken from Agricultural Machinery Assembly and Lubrication, The Center for Research and Leadership Development in Vocational and Technical Education, The Ohio State University, Columbus, Ohio.

UNIT: Lubricants and Lubricating Systems
TOPIC: Lubricants: Crankcase-Oil Viscosity (Grade) and Crankcase-Oil Type (Service Classification)
(Assignment Sheet continued)

Table From John Deere 3020 Tractor Operator's Manual OM - R39665

ENGINE OR AIR CLEANER OIL VISCOSITY

Depending upon the prevailing air temperature, use the following weight of oil in the engine crankcase and air cleaner:

DIESEL

Air Temperature	Single-Viscosity Oil	Multi-Viscosity Oil
Above 32°F. -10°F. to 32°F. Below-10°f.	SAE 30 SAE 10W	SAE 20W-40 SAE 10W-30 SAE 5W-20*

GASOLINE OR LP-GAS

Air Temperature	Single-Viscosity Oil	Multi-Viscosity Oil
Above 90°F. 32°F. to	SAE 30	SAE 20W-40
90°F. -10°F. to 32°F.	SAE 20W	SAE 10W-30
Below -10°F.	SAE 10W	SAE 10W-30
	SAE 5W*	SAE 5W-20

*Use of SAE 5W or 5W-20 oil may cause some increase in oil consumption. Check oil level more often when using this oil.

Be sure to select the oil you will use both by viscosity and by expected type of engine service; for example - ASE 20W-40, Service DS, for diesel engines; or SAE 20W-40, Service MS, for gasoline or LP-Gas engines.

UNIT: Lubricants and Lubricating Systems
TOPIC: Lubricants: Crankcase-Oil Viscosity (Grade) and
Crankcase-Oil Type (Service Classification)
(Assignment Sheet continued)

6. What results may be expected from using a lighter grade oil than is recommended?

7. What results may be expected from using a grade that is too heavy?

8. What are "multi-viscosity" oils?

9. How many grades of a single-grade oil may a multi-grade oil replace?

10. What do the letters API mean?

11. What do the following letters mean?
ML; MM; MS; DG; DM; Ds

12. Which API Service Classification is not recommended by any farm tractor manufacturer?

13. Using the table from the John Deere Operator's Manual and table IV, page 36, Reference 1, determine the SAE Grade and minimum API Class of oil to use for the following conditions: Determine for both spark ignition and diesel.
    a. Air temperature 80° F., mowing.
    b. Air temperature during working hours 80°-110° F., mowing.

ADDITIONAL INFORMATION: Under the current API Classifications disregard such terms as "Regular," "Premium," and "Heavy Duty," as they are not necessarily meaningful.

VOCABULARY: The following key words or terms have been used in this assignment and should now be a part of your vocabulary. Explain or define each:

Operator's manual
LPG
Multi-viscosity
SAE Grade
API Service Classification

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Lubricants and Lubricating Systems

TOPIC: Lubricants: Gear Oils, Hydraulic Oils, and Lubricating Greases

OBJECTIVE: To develop an understanding of the requirements for oils and greases in tractor lubrication and to develop the ability to select oils and greases for tractor lubrication other than for the engine.

INTRODUCTION: A hunter must know the caliber of his weapon and the purpose for which it is to be used before he can select the proper ammunition. A tractor mechanic should be just as knowledgeable about a tractor before making recommendations or servicing a transmission, differential, power take-off, pulley housing, final drive, or hydraulic system. The Farm Tractor Tune-Up and Service Guide (see reference) and also individual operator's manuals are very specific as to recommendations for the lubrication of each part of the tractor. These recommendations not only vary between manufacturers but also may vary between models of the same make. For example, some tractors use the same lubricant for the transmission and hydraulic system, whereas others require specific gear oil for one and a hydraulic oil for the other. Lubrication is the best preventive maintenance that can be performed but the lubricant must be used which has been determined by the manufacturer to satisfy the requirements of a particular machine. Never guess - look it up!

In the remainder of this assignment a closer look will be taken at gear oils, hydraulic oils, and lubricating greases. Opportunity will also be provided to compare the oil requirements of different makes of tractors.

UNIT: Lubricants and Lubricating Systems
TOPIC: Lubricants: Gear Oils, Hydraulic Oils, and Lubricating Greases
(Assignment Sheet continued)

REFERENCES: Required:

1. Information Sheet, "Lubricants and Lubricating Systems".
2. Selecting and Storing Tractor Fuels and Lubricants, pp. 40-45.
3. Farm Tractors-Basic Principles, Operation, and Maintenance. Engineering Bulleting No. FT-53, Table V, page 82.
4. Farm Tractor Tune-Up and Service Guide.

Supplemental:

5. Operator's Manual for the make of tractor student is studying.

QUESTIONS or ACTIVITIES:

1. Why are gear oils given a different set of viscosity-grade numbers and a different set of API classification (types) than crankcase oils?
2. What are the SAE numbers for gear oils? (Reference 2, Table V. page 82.
3. What are the four types of gear oils as established by the American Petroleum Institite?
4. What are the two types commonly used for tractor transmissions and differentials?
5. Why is it that a knowledge of the API service classification of gear oils cannot be used when servicing certain makes of tractors?
6. What are the two purposes for which hydraulic oils are used in tractors?
7. What are the four kinds of oils which may be used (depending on recommendation of the manufacturer) for hydraulic systems?

UNIT: Lubricants and Lubricating Systems
TOPIC: Lubricants: Gear Oils, Hydraulic Oils, and Lubricating Greases
(Assignment Sheet continued)

8. What are the functions of additives which are usually present in hydraulic oils?

9. What type of grease is recommended for most jobs which require a lubricating grease?

10. What are two common additives used in lubricating grease?

11. Using the Farm Tractor Tune-Up and Service Guide, determine the type and grade of oil for the systems of the following tractors.

	Power Steering	Implement Control	Transmission	Differential
WD Allis-Chalmers Gasoline				
John Deere 2-10 Gasoline				
Ford 501 Gasoline				
Oliver 1800 Diesel				

	Power Take-off	Pulley Housing	Final Drive
WD Allis-Chalmers Gasoline			
John Deere 2010 Gasoline			
Ford 501 Gasoline			
Oliver 1800 Diesel			

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Lubricants and Lubricating Systems

TOPIC: Lubricating Systems

OBJECTIVE: To develop an understanding of how oil lubricates an engine.

INTRODUCTION: The life of an engine depends to a great degree upon the type of lubrication it receives. Some engines require a special oil, some have special fittening devices , others have no filters, while still others have special devices to lubricate the engine.

In this study we will determine what is necessary to properly lubricate an engine.

REFERENCES: Required:

1. Farm Gas Engines and Tractors, Jones, pp. 332-345.
2. Machines for Power Farming, Stone and Gulvin, pp. 62-65.
3. Tractor Maintenance, AAAE and VA, pp. 21-28.

Supplemental:

4. "Gulf Farm Tractor Guide", pp. 36-37.
5. "Farm Tractors-Basic Principles, Operation, and Maintenance", Engineering Bulletin No. FT-53, pp. 59-64.
6. Dealers Manuel

UNIT: Lubricants and Lubricating Systems
TOPIC: Lubricating Systems
(Assignment Sheet continued)

QUESTIONS or ACTIVITIES:

1. A good lubrication system should be:
   a.
   b.
   c.
   d.

2. Although a lubricating system may have the above named features, it must also possess two additional factors to be completely satisfactory. These are:
   a.
   b.

3. The most important parts of a gasoline engine which require lubrications are:
   a.
   b.
   c.
   d.
   e.
   f.

4. Generally, engine lubrication systems may be classified in three groups. These are:
   a.
   b.
   c.

5. What maintains the correct pressure and controls the quantity of oil circulating in the force feed oil system?

6. What is the most widely used type of oil pumps?

7. Any engine having an enclosed crankshaft must have two oil indicators. These are:
   a.
   b.

8. What are two types of oil indicators?
   a.
   b.

UNIT: Lubricants and Lubricating Systems
TOPIC: Lubricating Systems
(Assignment Sheet continued)

9. If engine oil pressure drops rapidly the cause could be one or a combination of the following reasons:
   a.
   b.
   c.
   d.
   e.

10. Why is a breather a necessary part of an enclosed-crankcase engine?

11. What factors may cause oil dilution?

12. Many engines are equipped with a system of crankcase ventilation. What is the purpose of the ventilation system.?

13. What is the primary function of an oil filter?

14. Name five ways in which oil filters vary?
    a.
    b.
    c.
    d.
    e.

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Fuel Systems

TOPIC: Fuels and Principles of Combustion

OBJECTIVE: To develop an understanding of the properties of fuels and how they produce power.

INTRODUCTION: Will a gasoline engine operate efficiently with diesel fuel? If not, why? Each type fuel has its own characteristics and must be used in engines suited for that fuel.

REFERENCES: Required:

1. Information Sheet, "Fuels and Principles of Combustion".
2. Machines for Power Farming, Stone and Gulvin, Ch. 4.

Supplemental:

3. "Farm Tractors Basic Principles, Operation, and Maintenance," Engineering Bulletin FT-53.
4. "Gulf Farm Tractor Guide".
5. Modern Farm Power, Chapter 5
6. Tractor Fuels and Lubricants, Selecting and Storage, pp. 11-14

QUESTIONS or ACTIVITIES:

1. List the five essential characteristics of internal combustion fuels.
2. Fuel for internal-combustion engines are classified in two ways. Name them.

UNIT: Fuel Systems
TOPIC: Fuels and Principles of Combustion
(Assignment Sheet continued)

3. What are the three main classifications of fuel?

4. What are the three leading sources of LP gas?

5. What are the most common types of liquid fuels?

6. What is volatility?

7. Gasoling for automotive vehicles and stationary power units is available in what grades?

8. Distinguish between detonation and preignition.

9. Define and explain combustion as applied to internal combustion engine and hydrocarbon fuels.

10. What is octane rating of fuel?

11. How is diesel fuel graded and what are the main grades?

12. What is centane rating of diesel fuels?

13. What are the two worst enemies of diesel fuel?

VOCABULARY: The following words or terms have been used in this assignment and should be a part of your vocabulary. Define or explain each:

Distillate

LP gas

Detonation

Preignition

Combustion

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Information Sheet
on
FUELS AND PRINCIPLES OF COMBUSTION

Fuels for an internal combustion engine must be specific in nature for its operation to be successful. These fuels must have a reasonably high energy value, yet be of such nature that they can be handled and transported easily and safely. These fuels must vaporize at least partially at fairly low temperatures and the vapors must ignite and burn readily when mixed with oxygen in correct proportions. These fuels must also be relatively safe for use and not too harmful or dangerous to human health and life.

Fuels for internal combustion engines may be classified as either gaseous or liquid according to the physical state before entering the engine cylinder. These fuels are also classified according to their origin as natural or artificial. The most common gaseous fuels derived from a natural origin is natural gas and LP gas. Natural gas, due to its properties, is used very limited for internal combustion engines. LP gases are used more frequently and are by-products of petroleum refining process.. LP gases are derived (1) from dry gas and gasoline as it is removed from crude oil, (2) from recycling plants from the wet gas drawn from natural gas wells, or (3) from the normal processing of crude oil into commercial gasolines and distillates.

The more common types of liquid fuels derived from petroleum are gasoline, kerosene, distillate and diesel. These fuels are more easily stored and transported than the gaseous fuels.

The above mentioned fuels are of a natural origin, orininating from petroleum. There are many variations in character of crude oil depending somewhat upon the location where it was obtained. In the refining process of crude oil it is converted into hundreds of commercial products by various distillation and refining processes. One of these products is gasoline. Today we have four grades of gasoline available. These are white or fourth grade, regular, premium, and super premium. Premium grade gasolines have the best anti-knock characteristics and are usually somewhat higher quality fuels. Although a person may use the highest quality fuel possible, there are still some impurities that may cause trouble. The two main natural impurities are gum and sulphur.

Fuels and Principles of Combustion
(Information Sheet continued)

Today the tendency toward higher compression rations have caused a need for some change in tractor and automotive fuels. This higher compression has resulted in a pronounced fuel knocking effect termed detonation. Often this is confused withpreignition, however, there is a distinctive difference. Detonation occurs during the process of combustion , whereas preignition occurs when the fuel change is fired too far ahead of the compression dead center position of the piston. Today anti-knock additives such as tetraethyl lead is being used in gasoline to assist in eliminating engine knocks.

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Material for this Information Sheet was taken from Farm Gas Engines and Tractors, Jones. Fourth Edition.

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Fuel Systems

TOPIC: Gasoline Systems

OBJECTIVE: To develop an understanding of the parts of a gasoline fuel system and their functions.

INTRODUCTION: We know that an engine utilizes air and fuel in its process of operation, but do you understand how these are utilized? Will an engine run on gasoline without air? Just how is the air and gasoline mixed?

In this topic we will study the function of the gasoline fuel system and its operation in relation to the whole engine.

REFERENCES: Required:

1. Modern Farm Power, Ch. 6
2. Machines for Power Farming, Stone and Gulvin, Ch. 4
3. "Farm Tractors, Basic Principles, Operation and Maintenance," Humble Engineering Bulletin No. FT-53, pp. 10-18

Supplemental:

4. Service manual for make of tractor being studied.

QUESTIONS or ACTIVITIES:

1. What is the function of the carburetor?
2. How do air-fuel mixtures differ in cold or hot engines?
3. What are the four systems of a carburetor?

UNIT: Fuel Systems
TOPIC: Gasoline Systems
(Assignment Sheet continued)

4. What are two types of carburetors classified according to the direction of air travel through them?

5. Explain the function of the manifold heat control.

6. What is a simple type test a person can use to check the float level of a carburetor?

7. Explain how to adjust the idle screws of a carburetor?

8. Explain the adjustment of the load system of a carburetor.

9. What is the venturi? Explain its function in the carburetor.

10. What is responsible for maintaining a constant fuel level in the carburetor and why is it important to maintain a constant level?

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Fuel Systems

TOPIC: L. P. Gas Systems

OBJECTIVE: To develop an understnading of the operation, care, and utilization of liquefied petroleum gas on farm tractors.

INTRODUCTION: In what ways are LP Gas tractors like gasoline tractors? In what ways do they differ? Will they perform the same as a gasoline tractor? These questions and others will be studied in this unit and with careful reading and study you can make these comparisons.

REFERENCES: Required:

1. Tractor Maintenance Principles and Procedures, pp. 62-63.
2. Information Sheet, "Liquid Petroleum Systems"
3. Farm Tractors, Basic Principles, Operation and Maintenance, FT-53.
4. "Gulf Farm Tractor Guide".

Supplemental:

5. Modern Farm Power, Bishop and Promsberger.

QUESTIONS or ACTIVITIES:

1. Why is butane and propane mixed for tractor fuel purposes?
2. Why is butane and propane mixed for storage?
3. What are the primary differences between a gasoline and LP engine? Trace the LP gas through its fuel system.

UNIT: Fuel Systems
TOPIC: L. P. Gas Systems
(Assignment Sheet continued)

4. What are the advantages of LP gas over gasoline?

5. On a per gallon basis, which fuel, gasoline or LP gas, has the most power? Explain.

6. What are the disadvantages of LP gas?

7. Explain the differences in carburetors of gasoline and LP gas engines?

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Fuel Systems

TOPIC: Governors

OBJECTIVE: To develop an understanding of the purpose of an engine governor and to determine how it operates.

INTRODUCTION: In farm work it is almost essential that stationary engines maintain a constant speed whether under load or not. To do this the engines are equipped with governing devices.

In this lesson we will study the governing device, its construction, its operation, and how it will effect engine operation.

REFERENCES: Required:

1. Modern Farm Power, Promersberger and Bishop, Ch 8.
2. Tractor Maintenance Principles and Procedures, AAAE-VA, pp. 126-128.

Supplemental:

3. "Farm Tractors Basic Principles, Operation and Maintenance," Engineering Bulletin No. FT-53, pp. 18-20

QUESTIONS or ACTIVITIES:

1. What are the two types of governing systems?
2. What is the primary purpose of a governing system?
3. What is a governor hunting?
4. What is the cause of governor hunting?

UNIT: Fuel Systems
TOPIC: Governors
(Assignment Sheet continued)

5. What type governors do motor vehicles use?

6. Explain the method of operation of the hit and miss system of governing.

7. Explain the governing method of the throttle system.

8. What type governing system do all tractors have?

9. What is the main use of the hit and miss system?

10. Explain the method of operation of the vacuum system of governing.

11. How are diesel engines governed?

12. On what type engines is the vane-type governor used? Explain its method of operation.

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Fuel Systems

TOPIC: Diesel Fuel Systems - Principles of Operation, Combustion Chambers, Air Systems and Starting Aids

OBJECTIVE: To develop an understanding of the principle differences between the operation of a diesel and that of a gasoline engine.

INTRODUCTION: Basically we know that all internal combustion engines operate similarly but we need to have a working knowledge of the differences which exist in a diesel.

In this topic we will study some of these differences of operation and construction of combustion chambers and the air system.

REFERENCES: Required:

1. Modern Farm Power, Promersberger and Bishop, pp. 13, 29, 41-43.
2. Tractor Maintenance Principles and Procedures, pp 93, AAAE & VA.
3. Tractor Fuels and Lubricants, Selecting and Storing, page 11. AAAE & VA.

Supplemental:

4. Diesel and High Compression Gas Engines, Kates.

QUESTIONS or ACTIVITIES:

1. Review the principles of operation of a two and four stroke diesel engine. (Unit II Topic 1)

UNIT: Fuel Systems
TOPIC: Diesel Fuel Systems - Principles of Operation, Combustion Chambers, Air Systems and Starting Aids
(Assignment Sheet continued)

2. What causes combustion in a diesel engine?

3. How does the intake stroke of a diesel differ to that of a carburetor type engine?

4. When and how is the fuel added in a diesel engine?

5. After the fuel is added, when does ignition take place?

6. Why is it extremely important to keep the diesel engine fuel system clean?

7. Why is it necessary for the cylinder of a diesel engine to be more strongly constructed than that of a carburetor type engine?

8. On the two stroke diesel engine how is air furnished to the cylinder?

9. Due to the fact that diesel have such high compression ratio, they may be difficult to start. What are some starting aids to help start them?

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Assignment Sheet
for
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UNIT: Fuel Systems

TOPIC: Diesel Fuel Systems, Injection Pump and Fuel Injectors

OBJECTIVE: To develop an understanding of the functions of the fuel system, injection pump and fuel injectors to the diesel engine.

INTRODUCTION: If you were asked to service the fuel system of a diesel tractor, could you do so? To be able to do this you would need to be familiar with the operation of a diesel fuel system, its parts and their function.

REFERENCES: Required:

1. Tractor Fuels and Lubricants, AAAE and VA, pp. 11-14
2. Tractor Maintenance, Principles and Procedures, pp. 93-99, AAAE & VA.
3. Modern Farm Power, Promersberger and Bishop, pp. 62-64

Supplemental:

4. "Gulf Farm Tractor Guide"
5. "Farm Tractors, Basic Principles, Operation and Maintenance", Engineering Bulletin No. FT-53

QUESTIONS or ACTIVITIES:

1. What is the most important thing to do when changing fuel filters on diesel engines?
2. What are the parts of a diesel fuel system?

UNIT: Fuel Systems
TOPIC: Diesel Fuel Systems, Injection Pump and Fuel Injectors
(Assignment Sheet continued)

3. What is the purpose of the injection pump on a diesel system?

4. What is the purpose of the extremely high pressure the injection pumps deliver?

5. For what purpose is the return fuel line?

6. What is the purpose of the first, second and third stage filter of the diesel fuel supply system?

7. What determines the number of filters used on an engine?

8. What other terminology is used for designating stages of filters?

9. What are the five kinds of filters that may be used on farm tractor diesel systems?

10. Why is it necessary to bleed fuel lines after changing a filter? What general procedure should be followed?

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Fuel Systems

TOPIC: Air Cleaners

OBJECTIVE: To develop an understanding of the function, kinds and systems of air cleaners on fuel systems of modern tractors.

INTRODUCTION: We would all agree that a tractor must "breathe". It is as true with a tractor as with a human that bad air opens the way for internal trouble.

In this lesson we will study how "bad" air can be filtered to produce clean air for the operation of the engine.

REFERENCES: Required:

1. Modern Farm Power, Ch. 9
2. "Farm Tractors" , Engineering Bulletin No. FT-53, pp. 26-29

Supplemental:

3. Tractor Maintenance, page 16
4. "Gulf Farm Tractor Guide", pp. 34-35

QUESTIONS or ACTIVITIES:

1. What are the three common types of air cleaners?
2. According to test, what location of the intake stack proved to be the most efficient?
3. What are the four requirements of an air filter for it to be considered as a well designed unit?

UNIT: Fuel Systems
TOPIC: Air Cleaners
(Assignment Sheet continued)

4. Explain the principle of operation of a dry type air cleaner.
5. Explain the principle of operation of the oil bath unit.
6. Explain the principle of operation of the oil soaked unit.
7. What is the proper way to clean each type filter?
8. What other parts of the air intake system should be checked and cleaned regularly?
9. How often should an oil bath cleaner be serviced?
10. What are some places where dust can enter the engine other than through the normal air entries?

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Fuel Systems

TOPIC: Intake and Exhaust Manifolds and Pipes

OBJECTIVE: To develop an understanding of the importance of the intake and exhaust systems to the overall operation of the engine.

INTRODUCTION: Are intake and exhaust manifolds and pipes essential to engine operation? What is the reason for special designing of these parts? In this lesson we will study how each of these relate to engine operation and why they are designed as they are.

REFERENCES: Required:

1. "Farm Tractors Basic Principles, Operation and Maintenance", Engineering Bulletin No. FT-53, pp. 30, 53.
2. Machines for Power Farming, pp. 52-53, Stone-Gulvin.

Supplemental:

3. Service manual for make of tractor being studied

QUESTIONS or ACTIVITIES:

1. What is the purpose of an intake manifold?
2. Are gaskets necessary between the intake manifold and the cylinder head? If so, what kind are used?
3. What are the functions of a gasket on the intake manifold?
4. What are the functions of a gasket on the exhaust manifold?

UNIT: Fuel Systems
TOPIC: Intake and Exhaust Manifold and Pipes
(Assignment Sheet continued)

5. Why is the intake manifold on many engines designed so that two cylinders will not draw on one intake port in sequence?
6. What effect does backpressure , caused by the muffler, have on the engine operation?
7. When replacing mufflers, what factors must be kept in mind?
8. Define inertia as related to intake manifolds.

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Cooling Systems

TOPIC: Liquid and Air Cooling Systems

OBJECTIVE: To develop an understanding of the operation and care of the cooling system of the modern farm engine.

INTRODUCTION: A tractor cooling system requires very little maintenance if it is given proper and regular care. Because of this fact, many cooling systems are neglected and can become a costly problem. In this study you will cover the function, operation, care and repair of liquid cooling systems.

REFERENCES: Required:

1. Modern Farm Power, Ch. 12 complete, Promersberger & Bishop.
2. Machines for Power Farming, Ch 5 complete, Stone&Gulvi

Supplemental:

3. Tractor Maintenance, Principles and Procedure, AAAE and VA, pp. 105-112
4. 'Farm Tractors Basic Principles, Operation and Maintenance", Engineering Bulletin No. FT-53, pp. 52-58

QUESTIONS or ACTIVITIES:

1. Gasoline burning engines usually have an operating temperature of how many degrees?
2. Trace the movement of the water in an engine.
3. What are two types of liquid cooling systems?
4. Explain how the radiator assists in cooling the engine.

UNIT: Cooling Systems
TOPIC: Liquid and Air Cooling Systems
(Assignment Sheet continued)

5. What is the function of the thermostat?

6. Do all liquid cooling systems utilize the water pump? Explain.

7. What is the purpose of the water pump?

8. What are the normal operating temperatures of tractor fuel and diesel fuel engines for the best efficiency?

9. What is the advantage of having a cooling system under pressure?

10. Some stationary engines are air cooled. Explain how that air alone is used to cool the engine.

11. What are some conditions that will cause an engine to run hot.?

12. Why should antifreeze be drained out of the radiator for summer work?

13. Does a thermo-siphon system use a thermostat?

14. Where is the thermostat located in an engine?

15. How often should the radiator of a tractor be flushed?

16. What are three results one might expect from an engine running too hot?

17. What are three results one might expect from an engine running too cold?

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Electrical Systems

TOPIC: Magneto System

OBJECTIVE: To develop an understanding of the operation, care, and required service of a magneto system on internal combustion engines.

INTRODUCTION: Do all tractors have starters? Generators? Batteries? To answer these questions we need to go back to our early tractor electrical system. The modern day tractor utilizes the battery ignition system, however, many of the smaller engines on balers, grain elevators, and such utilize the magneto system.

In this topic we will study the magneto system, its parts and method of operation.

REFERENCES: Required:

1. "Farm Tractors, Basic Principles, Operation and Maintenance", Engineering Bulletin No. FT-53, pp. 41-43

2. Modern Farm Power, pp. 106-110, Ch. 11 Promersberger & Bishop.

Supplemental:

3. Machines for Power Farming, Ch. 6, Stone & Gulvin.

4. "The Tractor Electrical System", AAAE & VA

QUESTIONS or ACTIVITIES:

1. What is the primary source of electrical current in the magneto system?

2. What are the advantages of having a magnetic rotor over a revolving armature?

UNIT: Electrical Systems
TOPIC: Magneto System
(Assignment Sheet continued)

3. When is electrical current produced by a magneto the greatest?

4. How is the current produced in the primary windings?

5. What is the purpose of the condenser?

6. How is the extremely high voltage of an electrical system produced?

7. On a six cylinder engine, what is the ordinary speed of the armature or rotor of the magneto?

8. What is an impulse starter on a magneto, and how does it work?

9. What maintenance is necessary on a magneto?

10. What precaution is necessary when removing the distributor rotor?

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Electrical Systems

TOPIC: Introduction to the Battery Ignition System

OBJECTIVE: To develop an understanding of the purpose of the ignition system, the major components and the function of each.

INTRODUCTION: From the word "ignition" we would expect that the ignition system is designed to provide spark which ignites the fuel mixture in the cylinders. Since the spark plug extends into the combustion chamber, we know that the spark plug is one part of the ignition system. A "system" is defined as a number of things adjusted as a connected whole. The ignition system of a tractor is composed of a number of parts adjusted as a connected whole. In this assignment we will find out what these parts are, what they do, and how they are connected to the other parts to make a complete, functioning ignition system. In later assignments we will study each part of the ignition system in detail so that we will have the knowledge necessary to perform the services required of a tractor mechanic in maintaining a tractor engine at peak performance.

REFERENCES: Required:

1. Tractor Maintenance Principles and Procedures, pp. 78-80, AAAE - VA.
2. Modern Farm Power, pp. 102-106, Promersberger&Bishop.
3. Machines for Power Farming, pp. 69-70;78-80; Stone-Gulvin
4. 'Farm Tractors-Basic Principles, Operation, and Maintenance", pp. 43-44
5. "Gulf Farm Tractor Guide", pp. 27-28

UNIT: Electrical Systems
TOPIC: Introduction to the Battery Ignition System
(Assignment Sheet continued)

QUESTIONS
or
ACTIVITIES:

1. What are the two functions performed by the ignition system?
2. What controls the primary circuit?
3. The cam rotates, thereby providing the motion for opening and closing the breaker points. How is the cam powered?
4. Trace the path of the current through the primary circuit.
5. What is the meaning of the word "ground"?
6. What is the only reason for the current flow of the primary circuit?
7. What operation is performed by the distributor in breaking the primary circuit, thereby making the secondary circuit possible?
8. Why is it necessary to have the high voltage that is developed in the secondary winding of the ignition coil?
9. Trace the path of the current of the secondary circuit from the ignition coil back to the coil.
10. What is the purpose of the condenser?
11. List the major components of a battery ignition system.
12. List the major parts of a functioning distributor.

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Electrical System

TOPIC: The Battery

OBJECTIVE: To develop an understanding of the battery construction and its function to the electrical system.

INTRODUCTION: The source of power for the electrical system is the battery. The construction of the battery is important to the mechanic as it utilizes chemicals in the process of storage.

These chemicals, the construction, the function, and the care of the battery will be important to us in this study.

REFERENCES: Required:

1. Modern Farm Power, Promersberger & Bishop, pp. 112-114.
2. Machines for Power Farming, Stone & Gulvin, pp. 70-71;84-85.
3. "Farm Tractors, Basic Principles, Operation, and Maintenance", Engineering No. FT-53.

Supplemental:

4. Tractor Maintenance, AAAE-VA, pp. 51-53.
5. "Gulf Farm Tractor Guide", pp. 26-27.

QUESTIONS or ACTIVITIES:

1. What are the five main parts of a battery?
2. From what is the case of the battery made?
3. How does weather effect the efficiency of a battery?
4. How many volts does each cell of the battery have?

UNIT: Electrical System
TOPIC: The Battery
(Assignment Sheet continued)

5. What is the condition of the electrolyte in a discharged battery?

6. Explain the method whereby a battery becomes discharged.

7. How is a battery charged?

8. Explain how to easily clean a battery.

9. What safety precautions should be taken when charging a battery?

10. How is the charge of a battery checked?

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910-VI-4

Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Electrical System

TOPIC: Generators, Alternators, and Accessories

OBJECTIVE: To develop an understanding of how the generator and alternator operate, their function to the tractor as a whole and their care. Also, to study other accessories of the electrical system.

INTRODUCTION: The term generate makes us think of the production of power. In this case the production of electrical power. In our study of the electrical system we need to know how to maintain the electrical power necessary to operate the modern farm tractor. In this topic we will study how this is done through the use of the generator, alternator, and regulator.

REFERENCES: Required:

1. Machines for Power Farming, Stone & Gulvin, pp. 71-77;86-87.

2. Modern Farm Power, Promersberger & Bishop, pp. 122-125.

3. "Farm Tractors, Basic Principles, Operation, and Maintenance," Engineering Bulletin No. FT-53, pp. 46-47.

4. Tractor Maintenance, Principles and Procedures, page 90, AAAE&VA.

Supplemental:

5. Repair manual for make of tractor being studied.

QUESTIONS or ACTIVITIES:

1. What is the function of the generator?

2. What is the function of the alternator?

UNIT: Electrical System
TOPIC: Generators, Alternators, and Accessories
(Assignment Sheet continued)

3. What is the function of the regulator?

4. What is the function of the cut out relay?

5. What three ways can the charging rate of the generator be controlled?

6. How do the methods mentioned in question 5 actually control the rate of charging?

7. What is the operational difference between a generator and voltage regulator?

8. What is the function of the ammeter?

9. What minimum service is required by the generator?

10. When cleaning the commutator, why can emery cloth not be used?

11. How is the generator polarized after a battery or wire has been changed?

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910-VI-5

Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT:	Electric System
TOPIC:	Starters
OBJECTIVE:	To develop an understanding of the operation and care of a starter on farm tractors.

INTRODUCTION: The term starters or starting motor leads a person to believe that something is beginning. The starter in this case is actually beginning the revolving process of the engine.

In this topic we will study the process of starting, the upkeep necessary and the differences between the starter and generator.

REFERENCES: Required:

1. Modern Farm Power, pp. 125-126, Promersberger & Bishop.
2. Machines for Power Farming, page 77, Stone & Gulvin.
3. Farm Tractors, Engineering Bulletin No. FT-53, pp. 47-48.

Supplemental:

4. Tractor Maintenance Principles and Procedures, AAAE&VA

QUESTIONS or ACTIVITIES:

1. In what ways are starters and generators similar?
2. How do starters and generators differ in construction?
3. How is the commutator on a starter cleaned?
4. When starting an engine how does the starter motor actually turn the tractor engine?
5. What is the result of continuous grinding in cold weather trying to start an engine?

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910-VII-1

Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Engine Testing and Tune Up

TOPIC: Timing the Ignition System

OBJECTIVE: To develop an understanding of the importance of a properly timed engine.

INTRODUCTION: Proper timing is essential to proper engine operation. All farmers are interested in the economy of their operation however many fail to realize how uneconomical a poorly timed engine is.

In this topic we will study the importance of proper timing and the method to follow in timing an engine.

REFERENCES: Required:

1. Farm Tractors Basic Principles, Operation and Maintenance, Engineering Bulletin No. FT-53, pp. 50-51.

2. Tractor Maintenance Principles and Procedures, pp. 86-89.

Supplemental:

3. Modern Farm Power, pp. 69-79, Promersberger & Bishop.

4. Machines for Power Farming, pp. 80-83, Stone & Gulvin.

QUESTIONS or ACTIVITIES:

1. What are the two methods of timing an engine?

2. What does timing actually mean?

3. Where may the timing marks of an engine normally be found?

4. How is the two wire timing light attached?
5. How is the three wire timing light attached?
6. How can a person determine when the number one piston is up on the compression stroke?
7. Where should the timing light be held and why?
8. When timing an engine by the breaker point method what is the relative position of the breaker points and timing marks?
9. When timing an engine, what should a person always do regarding instructions, timing marks, and adjustments?
10. What is retarded and advanced timing?
11. How is the diesel engine timed?

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910-VII-2

Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Engine Testing and Tune-Up

TOPIC: Valve Clearance Adjustments

OBJECTIVE: To develop an understanding of the importance of valves and how to properly adjust them.

INTRODUCTION: Most people know that there are valves in an engine but few know their purpose or how to adjust them. If a valve is improperly adjusted the result is often serious trouble to the farmer.

In this study we will consider the valve adjustments and how they effect proper engine performance.

REFERENCES: Required:

1. Modern Farm Power, pp. 79-80, Promersberger&Bishop.
2. Tractor Maintenance, Principles and Procedures, pp. 34-42. AAAE - VA
3. Farm Tractors, Basic Principles, Operation, and Maintenance, Engineering Bulletin No. FT-53, pp. 31-38.

Supplemental:

4. Machines for Power Farming, pp. 28-35, Stone-Gulvin.

QUESTIONS or ACTIVITIES:

1. By what other names may valve clearance adjustments be called?
2. What is valve clearance adjustment?
3. What are the two kinds of valves?
4. Why should valves be properly adjusted?

UNIT: Engine Testing and Tune-Up
TOPIC: Valve Clearance Adjustments
(Assignment Sheet continued)

5. Is valve adjustment made while the engine is hot or cold?

6. What tools are used to adjust valves?

7. At what point is the actual adjustment checked?

8. What is the purpose of the third racker arm per cylinder on a diesel engine?

9. Although valves are adjusted between the rocked arm and the valve stem where is the critical area of the valve?

10. How can valve springs be tested without a special testing device?

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910-XII-1

Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Hydraulics

TOPIC: Introduction

OBJECTIVE: To develop an understanding of how and why hydraulic principles operate, also to understand hydraulic theory and the basic systems involved in hydraulics.

INTRODUCTION: Hydraulics may be defined, in a strict sense, as the science of fluid forces. In modern usuage, hydraulics' has come to mean the use of fluid to transfer power, or to change a power source into useful force.

The use of hydraulic power on modern farm tractors and equipment is relatively new but the principle of hydraulic power dates back to early times. There are several branches of hydraulics, but the branch applicable to farm equipment deals with enclosed liquids under pressure.

REFERENCES: Required:

1. Tractor Hydraulics, American Association for Agricultural Engineering and Vocational Agriculture, pp. 1-8.

2. Farm Machinery and Equipment, Smith, Ch. 7, pp. 65-67.

Supplemental:

3. The Operation, Care, and Repair of Farm Machinery, Deere and Company, Ch. 6, pp. 56-66.

QUESTIONS or ACTIVITIES:

1. What is the definition of "hydraulics"?

2. Who discovered the fundamental law upon which modern machine hydraulics is based?

UNIT: Hydraulics
TOPIC: Introduction
(Assignment Sheet continued)

3. List the nine main features that make hydraulics so adaptable?

4. No mechanical device is perfect. What are two drawbacks of hydraulics?

5. Give the three basic theories of hydraulics?

6. Define: a. Hydrostatic Power
   b. Hydrodynamic Power

7. List the parts of a basic hydraulic system as illustrated on page 8, Tractor Hydaulics, AAAE&VA.

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910-XII-2

Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Hydraulics

TOPIC: Reservoir

OBJECTIVE: To develop an understanding of the purpose of a reservoir on hydraulic systems. To understand how to determine the size. Also to understand the parts of a reservoir.

INTRODUCTION: Every hydraulic system must have a reservoir. In most farm and industrial equipment applications, the reservoir is a built-in unit, although this may not be true in all cases. Due to compactness and convenient, compromise with ideal design is sometimes made.

REFERENCES: Required:

1. Tractor Hydraulics, American Association for Agricultural Engineering and Vocational Agriculture, pp. 9-10.

QUESTIONS or ACTIVITIES:

1. How is the size of reservoirs determined?
2. Give four reasons why the reservoir should be of adequate size.
3. List the parts of a reservoir as illustrated on page 9 of Tractor Hydraulics, AAAE&VA.

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910-XII-3

Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT:	Hydraulics
TOPIC:	Hydraulic Pumps
OBJECTIVE:	To develop an understanding of the different types of pumps on hydraulic systems. Also to understand the parts of the pump and how it operates.
INTRODUCTION:	The pump is the power supply of the hydraulic system and it is a percesion-built unit, of rugged design and high quality materials. Pumps are commonly thought of as compressors, but this is not true of hydraulic pumps. Since fluids are virtually incompressible except at extremely high pressures, the pump serves only to transmit force.
REFERENCES:	Required: 1. Tractor Hydraulics, American Association for Agricultural Engineering and Vocational Agriculture, pp. 10-17. 2. Farm Machinery and Equipment, Smith, Ch. 7, pp. 67-69.
QUESTIONS or ACTIVITIES:	1. Give the two classifications of pumps. 2. Which type of pumps does most farm and industrial equipment use? 3. Name the various types of pumps available on hydraulic systems. 4. Study the illustrations of the ten different types of pumps, pp. 11-16, Tractor Hydraulics, AAAE&VA.

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910-XII-4

Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Hydraulics

TOPIC: Hydraulic Valves

OBJECTIVE: It was mentioned earlier that hydraulic systems are basically simple and they are, if the presence of many valves, of several types, is not allowed to confuse understanding.

Until recently, valves were the only means of controlling fluids in a hydraulic system. With the advent of "variable delivery" pumps, certain values in systems having this type of pump may be eliminated. However, valves are still the most important method of controlling fluid pressure and flow, and obtaining wide flexibility in hydraulic systems.

REFERENCES: Required:

1. Tractor Hydraulics, American Association for Agricultural Engineering and Vocational Agriculture, pp. 17-24.

QUESTIONS or ACTIVITIES:

1. Nearly all the valves used in hydraulic systems may be classified into three categories. Name these three categories.
2. What are the five ways in which valves can be controlled?
3. Name the eleven specific-types of valves available for hydraulic systems.
4. Study the illustrations on page 17-23 in Tractor Hydraulics.

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910-XII-5

Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Hydraulics

TOPIC: Hydraulic Cylinders

OBJECTIVE: To develop an understanding of the cylinder and how it operates on hydraulic systems. Also to understand the different categaries of cylinders.

REFERENCES: Required:

1. Tractor Hydraulics, American Association for Agricultural Engineering and Vocational Agriculture, pp. 24-28.
2. Farm Machinery and Equipment, Smith, Ch. 7, pp. 69-73.

QUESTIONS or ACTIVITIES:

1. Cylinders may be classified into two general categories. Name these two categories.
2. Name five refinements found in the hydraulic cylinder.
3. Give the purpose of the hydraulic cylinder.

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT:	Hydraulics
TOPIC:	Hydraulic Seals and Packing
OBJECTIVE:	To develop an understanding of the different types of seals and packing used in hydraulic systems; also, to understand their general classification, and their functions.
INTRODUCTION:	None of the components of a hydraulic system so far discussed would operate without proper seals and packings to hold the fluid under pressure in the system.
REFERENCES:	Required: Tractor Hydraulics, AAAE and VA, pp. 28-30

QUESTIONS or ACTIVITIES:

1. Give the two classifications of seals and packings according to their use.
2. List the ten different types of seals and packings according to their shape.
3. Study pictures of the different types of seals and packings and be able to identify each.

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Hydraulics

TOPIC: Hydraulic Lines and Fittings

OBJECTIVE: To develop an understanding of the different types of lines and fittings used in hydraulic systems.

INTRODUCTION: No hydraulic system can be expected to operate without proper connections for moving the fluid between the various units of the system. Hydraulic lines must be designed and installed with the same care applied to the other parts of the system. They should be leakproof and strong enough to stand the maximum pressure, temperature, and vibration of the system involved. They should not be constructed of materials, or designed in a way, that will cause restriction of flow and turbulence. They should be large enough to carry the maximum pump output without excessive friction losses or turbulence. They should be as short as possible and have as few bends as possible. Hydraulic lines may be off piping, tubing or flexible hose.

REFERENCES: Required:

Tractor Hydraulics, AAAE and VA, pp. 30-31

QUESTIONS or ACTIVITIES:

1. What are the different types of metals used in piping and tubing?

2. Why should one never use galvanized pipe in a hydraulic system?

3. Give the bending radius of piping and tubing and also flexible hose.

4. List the five various types of hydraulic line fittings as illustrated on page 31, Tractor Hydraulics.

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Assignment Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Hydraulics

TOPIC: Hydraulic Systems

OBJECTIVE: To develop an understanding of the different types of hydraulic systems and how they operate. Also, to understand the application of these systems.

INTRODUCTION: In order to be able to fully understand the application of hydraulics to equipment, it is necessary to understand what is meant by the descriptive terms applied to various kinds of hydraulic systems.

Four components are all that are necessary to have a workable hydraulic system--A reservoir, a pump, a valve, and a motor (cylinder).

Descriptive titles for the various systems discussed in this topic are based on the type of valve used, or its operation.

REFERENCES: Required:

Tractor Hydraulics, American Association for Agricultural Engineering and Vocational Agriculture, pp 35-38

QUESTIONS or ACTIVITIES:

1. Name the four components which are necessary to have a workable hydraulic system.
2. List the five different hydraulic systems.
3. Study the five different hydraulic systems on page 36-38, Tractor Hydraulics and be able to describe the action of each.
   a. Follow the fluid through the block return line system naming the parts through which it goes, to raise the cylinder plunger in illustration 49.

UNIT: Hydraulics
TOPIC: Hydraulic Systems
(Assignment Sheet continued)

b. Upon pulling the lever that releases the fluid, list the parts in order through which the fluid flows on its return trip to the reservoir.

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910-I-1a

Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Introduction

TOPIC: Orientation

1. To be able to do their jobs with a high degree of speed and efficiency.

2. They provided the farmer with efficient production tools which has lowered the cost of production.

3. No

4. Produce food and fiber for twenty-nine others.

5. It has provided them more free time to devote to other activities.

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910-I-1a

Answer Sheet to Test on ORIENTATION

1. T
2. F
3. F
4. T
5. T

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Introduction

TOPIC: Orientation

1. Through the branch house and a dealer.

2. Engineers employed by the manufacturer.

3. Through the branch house.

4. The dealer.

5. The branch house.

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Answer Sheet for Test
on
ORIENTATION

1. Manufacturer - Branch house - Dealers - Customers

2. Keeps in touch with machinery problems and develops new machines

3. To move the machinery from the factory to the dealers

4. a. Sales
   b. Clerical
   c. Parts
   d. Service

5. a. Set-Up Man
   b. Mechanic's Helper
   c. Service Supervisor
   d. Parts Man
   e. Delivery Man

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910-I-1c

Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Introduction

TOPIC: Orientation

1. a. Management
   b. Sales
   c. Clerical
   d. Parts
   e. Service

2. a. Determine company policies
   b. Exercise financial control over the business
   c. Select, train and supervise employees
   d. Forcast and plan future company business
   e. Direct customer and employee relations
   f. Promote sales
   g. Coordinate jobs

3. a. Finds prospective buyers
   b. Conducts demonstrations
   c. Appraises used machinery
   d. Closes sales
   e. Makes financial arrangement for customer to purchase machinery
   f. Maintains sales room
   g. Follows up past sales

4. a. Dispenses shop parts
   b. Dispenses customer parts
   c. Maintains parts inventories
   d. Checks inventories
   e. Maintains price catalogue
   f. Constructs displays
   g. Maintains parts identification

5. a. Makes general repairs
   b. Handles field repairs
   c. Conducts special operations
   d. Reconditions trade-ins

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Answer Sheet for Test
on
ORIENTATION

1. (a) Management
2. (b) Sales
3. (b) Sales
4. (e) Service
5. (c) Clerical
6. (d) Parts
7. (e) Service
8. (b) Sales
9. (a) Management
10. (e) Service

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Introduction

TOPIC: General Shop Safety

1. You must understand the hazards of the job you are about to do and be willing to practice safety habits.

2. It distracts you from your work.

3. Can result in injury

4. Wash hands using soap

5. Place feet close to object, keep elbows straight, use large leg muscles, and keep back straight

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Answer Sheet for Test
on
GENERAL SHOP SAFETY

1. T

2. T

3. T

4. F

5. F

6. T

7. T

8. T

9. F

10. T

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910-I-4a

Answer Sheet
for
INTRODUCTION

UNIT: Introduction

TOPIC: Hand Tools-Identification and Use of Metals and Layout Tools

1. a. Amount and kind of materials added to the pig iron
   b. Kind of heat treatment

2. Annealing

3. Long, bright, crackling

4. 12 inch

5. Scribing lines on metal

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910-I-4a

Answers Sheet for Test
on
SELECTING AND USING METALS AND LAYOUT TOOLS

True or False:

1. True
2. False
3. True
4. True
5. False

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Answer Sheet
for
INTRODUCTION

UNIT: Introduction

TOPIC: Hand Tools-Cutting Cold Metal

1. Hard-back blades break more easily.

2. a. Flat
   b. Cape
   c. Diamond point
   d. Round

3. When cutting round stock, roll the metal and cut about one-third of the way through, all the way around;then break the metal over the anvil.

4. a. Wrought iron
   b. Low carbon steel

5. The cold chisel must be harder than the metal it is to cut.

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Answer Sheet for Test
on
HAND TOOLS-CUTTING COLD METAL

1. Lengths
2. Harder
3. Bolt cutters
4. Round
5. Split

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Answer Sheet
for
INTRODUCTION

UNIT: Introduction

TOPIC: Hand Tools-Shaping Stock and Filing

1. The metal is weakened.

2. a. Vise
   b. Wrench

3. High-carbon, specially hardened steel

4. a. Length
   b. Point
   c. Face
   d. Edge
   e. Heel
   f. Tang

5. The tang should be fitted into a handle.

6. a. Flat double cut
   b. Flat single cut
   c. Half Round
   d. Round
   e. Square
   f. Crosscut saw
   g. Triangular saw (tapered)
   h. Triangular saw (blunt)

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910-I-4c

Answer Sheet for Test
on
HAND TOOLS-SHAPING STOCK AND FILING

1. Weaken

2. Hardened

3. Rough

4. Slower

5. Card

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910-I-4d

Answer Sheet
for
INTRODUCTION

UNIT: Introduction

TOPIC: Hand Tools-Drilling

1. Power drill press

2. No. 80

3. 1/64 inch

4. The metal may spin and injure the operator.

5. V-shaped

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910-I-4d

Answer Sheet for Test
on
HAND TOOLS-DRILLING

1. V

2. 1/64

3. Turn or spin

4. Letters, fractions

5. Harder

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Answer Sheet
for
INTRODUCTION

UNIT: Introduction

TOPIC: Hand Tools-Tapping and Threading

1. a. National Coarse
   b. National Fine

2. National Fine

3. a. Taper
   b. Plug
   c. Bottoming

4. a. Round split die
   b. Two-piece die
   c. Solid die

5. A screw plate is a bolt-threading set that contains dies, die stocks, taps, and tap wrenches.

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Answer Sheet for Test
on
HAND TOOLS-TAPPING AND THREADING

1. a. National Coarse
   b. National Fine

2. a. Taper
   b. Plug
   c. Bottoming

3. a. Roung split die
   b. Two-piece die
   c. Solid die

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910-I-6a

Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Introduction

TOPIC: The Parts of Machines

1. The function and application of a cam is to produce intermittent motion. This is done by action of the lobe or nose as it turns by the shaft causing the tappet to raise and lower as the nose turns by it.

2. The difference between a friction and anti-friction bearing is that the friction bearing is in direct contact with the shaft whereas the anti-friction bearing has rollers or balls placed between the shaft and the supporting bearing, thereby reducing the friction.

3. The function of a bearing is to hold the various power transmission parts in position.

4. Types of ball bearings:
   a. Internally self-aligning bearings
   b. Single row deep groove bearings
   c. Loading groove bearings
   d. Single row angular contact bearin
   e. Double row deep groove bearings
   f. Double row angular contact bearin
   g. Ball thrust bearings

5. Types of roller bearings:
   a. Spherical
   b. Straight
   c. Tapered
   d. Spherical thrust
   e. Needle
   f. Thrust

6. Roller bearings differ from ball bearings in that small cylindrical rollers are substituted for the balls which gives a much larger bearing surface.

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910-I-6a

Answer Sheet for Test
on
THE PARTS OF MACHINES

1. The function of bearings in farm equipment is to hold the various power transmission parts in position.

2. Factors determining proper bearing selection are:
   a. Amount of wear
   b. Speed of turning shaft
   c. Load to be carried
   d. Amount of end thrust

3. Proper lubrication is essential to long life and service.

4. Bushings may be made from:
   a. Wood
   b. Babbitt
   c. Bronze
   d. Chilled iron

5. Two types of bearing bushings are:
   a. Straight bearings
   b. Graphited oiless

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910-I-6b

Answer Sheet
for
FASTENING DEVICES

UNIT: Introduction

TOPIC: The Parts of Machines

PART I:

1. 2
2. 4
3. 1
4. 5
5. 4
6. 1
7. 3
8. 2
9. 3

PART II: A

1. Flat head machine screw
2. Lock washer
3. Hex head cap screw
4. Cotter pin
5. Castellated nut
6. Hex head bolt
7. Jam (or lock) nut
8. Light nut

PART II: B

1. Phillips
2. Slotted
3. Hexagon recessed (or Allen)
4. Square
5. Hexagon
6. Clutch

UNIT: Introduction
TOPIC: The Parts of Machines
(Answer Sheet continued)

PART II: C

1. Round
2. Flat
3. Oval
4. Fillister

PART III:

1. 0
2. +
3. +
4. +
5. +
6. 0
7. +
8. 0
9. 0
10. +
11. 0
12. +
13. +
14. 0
15. +
16. +
17. +
18. 0
19. +
20. +
21. 0
22. 0
23. +
24. 0
25. 0
26. 0

PART IV:

1. American Standard
2. Coarse and Fine
3. NC (or USS) and NF (or SAE)
4. The distance between corresponding points of adjacent
5. 60
6. Flats (or faces)
7. Heavy (or standard), light, and jam (or lock)
8. 1-1/2
9. Under head to end
10. Wrenches
11. Self tapping
12. Sheet metal and Parker
13. Stud (or stud bolt)
14. Shakeproof
15. Jam (or lock) nut
16. Upsetting
17. Square, hex socket (or Allen), and headless
18. Ounce or pound

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910-I-6b

Answer Sheet for Test
on
FASTENING DEVICES

PART I:

1. 2
2. 1
3. 1
4. 2

PART II:

1. Phillips
2. Slotted
3. Hexagon recessed (or Allen)
4. Square
5. Hexagon
6. Clutch

PART III:

1. +
2. 0
3. 0
4. 0

PART IV:

1. American Standard
2. Under head to end
3. Shakeproof
4. Jam (or lock) nut

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Introduction

TOPIC: Transmission of Power

1. Six methods of transmitting power of farm equipment are:
   a. Direct drive
   b. Pulleys and belts
   c. Sprocket wheels and chain
   d. Gears
   e. Shafts and universal joints
   f. Flexible shafting

2. The advantage of a V-belt over a flat belt is that the V-belt has less belt slippage due to greater tractional contact between the sides of the belt and sheave flanges.

3. To properly fit a V-belt it should run in the sheave groove with the top surface almost flush with the top of the groove and at least 1/8 inch clearance under the belt in the bottom of the groove.

4. Belt lengths can be determined in the case of a V-belt by using the formula $L-2c + 1.57(D+d) + \frac{(D+d)^2}{4c}$ where
   L = effective length of belt, inches
   d = distance between centers of sheaves, inches
   D = effective outside diameter of large sheave, inches
   d = effective outside diameter of small sheave, inches
   In the case of flat belts to find the length add the diameters of the two belts together, divide by 2 and multiply by 3. To this product add twice the distance between the centers of the two shafts.

5. To calculate this speed or size of the pulley use the formula 5 X D = 5 X D. Where three of the quantities are known the forth can easily be found.
   S = r.p.m. D = diameter.

6. The pitch of the sheave will vary the speed because as the pitch is widened the belt will be running on a smaller diameter there by causing the speed of the pulley being driven to slow down. The pitch of alternate sheaves should be changed to vary speeds.

UNIT: Introduction
TOPIC: Transmission of Power
(Answer Sheet continued)

7. When using pressed steel hook chains run the hook end forward and slot side out when the larger of the sprockets is the driver. When the smaller of the sprockets is the driver, the chain should run in reverse direction.

8. a. Spur
   b. Cluster
   c. Internal spur
   d. Herringbone
   e. Helical
   f. Worm and worm heel
   g. Straight level
   h. Straight level gear set
   i. Spiral-level set used in tractors
   j. Hypoid gear set
   k. Spline-shaft gear

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Answer Sheet for Test
on
TRANSMISSION OF POWER

1. The six methods of transmitting power in farm equipment are:
   a. Direct drive
   b. Pulley and belts
   c. Shafts and universal joints
   d. Gears
   e. Sprocket wheels and chains
   f. Flexible shafting

2. To properly fit a V-belt it should ride about level with the top of the sheave flanges and clear the bottom of the pulley about 1/8.

3. The length would be calculated as follows:

$$L = 2C + 1.57\,(D + d) + \frac{(D + d)^2}{4c}$$

$$L = 2(24) + 1.57\,(8 + 4) + \frac{4^2}{4(24)}$$

$$L = 48 + 1.57\,(12) + \frac{16}{96}$$

$$L = 48 + 18.84 + .17$$

L= 67 inches

4. The diameter would be calculated as follows:

$S \times D = S \times D$
$1800 \times 6 = 2400 \times (X)$
$10800 = 2400X$
$2.5 = X$

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Introduction

TOPIC: Tractor Design

1. a. Wheel types
    1. All-purpose, most all farm work especially row-crop work
    2. Standard for general farmwork (open field work) but not major row crops
    3. Orchard
    4. Utility

   b. Crawler type or tracklayer

   c. Garden tractors

2. The all-purpose type is most popular because of its diversity of use. About 92% of all tractors sold for farm use are all-purpose and utility types (wheel type), 5% standard and 3% crawlers or tracklayers.

3. Tractors are rated according to horsepower and capacity meaning the width and number of moldboard plows the tractor can use.

4. All tractors are alike in the following ways:
   a. An internal-combustion engine as a source of power
   b. A clutch to connect and disconnect the engine power and the driven parts.
   c. A transmission system for conveying power to the driving members or to other points where applied.

5. The basic elements of all farm tractors are:
   a. An engine
   b. A clutch
   c. A transmission
   d. A final drive

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Answer Sheet for Test
on
TRACTOR DESIGN

1. a. Wheel type
    1. All-purpose
    2. Standard
    3. Orchard
    4. Utility
   b. Tracklaying or crawler type
   c. Garden

2. Tractors are also classified according to their adaptability to certain kinds of farm work such as field work, tilling, harvestin g, haying, and etc.

3. The all-poupose type tractor is more widely used because of its versitility.

4. a. Tricycle
   b. Wide front axle
   c. One row or auxiliary

5. Features of an orchard or grove tractor:
   a. Narrow tread wheels and short wheel base
   b. Steering wheel and operators seat are lowered and protected by a cowl.
   c. Overall height of the tractor is reduced
   d. Projecting parts are covered
   e. Designed to give added stability and safety

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Internal Combustion Engines

TOPIC: Theory of Operation

1. A four cycle engine is one having four strokes or movements of the piston to complete the action necessary to produce power. Such an engine requires two complete revolutions of the crankshaft for each full cycle of events.

2. A two cycle engine is one having only two strokes or movements of the piston to complete the action necessary to produce power.

3. The four cycle carburetor type engine operates with four decisive strokes of the piston. The first stroke, known as the intake stroke, takes in a mixture of air and fuel through the intake valve which is open. The intake valve then closes and the piston begins its upward stroke or compression stroke until it reaches T. D. C. (Top Dead Center) of the crankshaft. This stroke has compressed the fuel-air mixture into a very small space between the piston and cylinder head. The third stroke then takes place when the spark from the spark plug ignites the compressed fuel and air causing a downward movement of the piston. This stroke is the power stroke causing the crankshaft to turn 180°. The fourth stroke is the upward movement of the piston while the exhaust valve is open driving out the burned gases.

4. The operation of a two cycle carburetor type engine is much the same as that of a four cycle engine. The main differences are that with each stroke of the piston two events take place rather than one, and the crankshaft makes only one revolution. This engine makes use of an air tight crankcase for partially compressing the fuel and air mixture. As the piston travels down the mixture previously drawn into the crankcase is partially compressed. As the piston nears the bottom of the stroke it uncovers the exhaust and intake parts. The exhaust then flows out reducing the pressure in the cylinder. This reduces the pressure in the cylinder lower than that in the crankcase allowing the new fuel charge to flow into the cylinder through the port openings. The incoming mix-

ture is deflected upward by a baffle on the piston. As the piston travels upward, it compresses the mixture above and draws a new air-fuel mixture into the crankcase. The engine then fires, driving the piston down and thereby beginning another stroke.

5. Lubrication in a two cycle engine is provided for by mixing the oil and fuel.

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Answer Sheet for Test
on
THEORY OF OPERATION

1. Intake: Air and fuel mixed in the carburetor are drawn into the cylinder through the open intake valve by the downward action of the piston.
   Compression: Both valves are closed and the air-fuel mixture is compressed in the upper part of the cylinder by the upward motion of the piston.
   Power: An electrical charge is produced by the spark plug igniting the compressed air-fuel mixture. The expansion of the fuel drives the piston down turning the crankshaft. Both valves are closed.
   Exhaust: The exhaust valve opens and the burned fuel fumes are driven out by the upward movement of the piston.

2. Intake and Exhaust: At the bottom of the power stroke the piston travels below the port openings and allows the fuel previously partially compressed in the crankcase to flow into the cylinder. This drives the fumes of the burned fuel out the exhaust port on the opposite side of the cylinder. The fresh fuel is deflected upward by a baffle on the piston.
   Compression and power: As the piston travels up, it closes the intake and exhaust ports and compresses the fuel-air mixture in the top of the cylinder. As the piston reaches the top of its travel, a spark is injected by the spark plug igniting the compressed fuel, thereby forcing the piston back down.

3. Equipment requiring small power requirements such as garden tractors, power lawn mowers, outboard engines, etc.

4. Mixing oil with fuel

5. A strokeis the movement of the piston from top of the stroke or T. D. C. (Top Dead Center) to the bottom of the stroke of C. D. C. (Crank Dead Center).

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Internal Combustion Engines

TOPIC: Engine Types

1. Gasoline, L. P. (liquid petroleum) and Diesel.

2. Fuel system
   Lubrication system
   Ignition and electrical system
   Cooling system

3. Cylinders
   Pistons
   Valves and valve opening parts
   Piston rings
   Cylinder head
   Piston Pin
   Connecting rod
   Crankshaft
   Flywheel
   Crankcase (block)

4. The block of a diesel must be designed to withstand more pressure per square inch and a higher operating temperature, [illegible]

5. Engines are classified according to cylinders by numbers. An engine may have one, two, four, six or eight cylinders and up. They are also classified according to horizontal or vertical cylinders.

6. An engine is classified as a straight block meaning all pistons fall in a straight line. A vee (V) block indicating that the pistons are in two rows opposite each other.

7. In most engines each cylinder has two valves; one intake and one exhaust. In a two cycle engine the cylinder does not have any valves. The piston acts somewhat like a valve by passing over port holes in the cylinder wall allowing the movement of air and fuel.

UNIT: Internal Combustion Engines
TOPIC: Engine Types
(Answer Sheet continued)

7. Crankshaft - the longest shaft in the engine which transforms the reciprocating action of the pistons into a rotary motion.

8. Spark plug - a part fitting into the head of a cylinder which has two electrodes separated by an air gap across which the current from the ignition system discharges to form a spark thereby igniting the fuel present in the cylinder

9. Cylinder - often called the heart of the engine. With in the cylinder the process of combustion takes place.

10. Connecting rod - the rod which transmits the pressure of the piston to the crankshaft

11. Fuel injector - a pump-like device used to inject fuel under pressure into the cylinder of a diesel engine.

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Answer Sheet for Test
on
ENGINE TYPES

1. a. Cooling system
   b. Fuel system
   c. Lubrication system
   d. Ignition and electric system

2. a. Cylinders
   b. Pistons
   c. Piston rings
   d. Valves
   e. Valve opening parts
   f. Cylinder head
   g. Piston pin
   h. Connecting rod
   i. Crankshaft
   j. Flywheel
   k. Crankcase (block)

3. Diesel and carburetor type engines differ in the following ways:
   a. Block construction
   b. Compression ratios
   c. Method of igniting fuel
   d. Method of fueling cylinder
   e. Operating temperature or cooling system

4. a. The size of the cylinder is known as the bore.
   b. Piston stroke is the distance traveled by the piston moving from its extreme upper positions to its extreme lower position as expressed in inches.
   c. Piston displacement is a measure of the volume displaced by the pistons during one complete stroke, as expressed in cubic inches.
   d. Fuel injector is a pump like device used to inject fuel under pressure into the cylinder of a diesel engine.
   e. The crankshaft is the largest shaft in the engine which transforms the reciprocating action of the pistons into a rotary motion.

5. The advantage of a sleeve type cylinder is that when the cylinder walls become severely worn that sleeve may be removed and a new sleeve installed , thereby giving new cylinder walls.

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Internal Combustion Engines

TOPIC: Power Measurement

1. Horsepower is the rate of doing work equivelent to raising 33,000 lbs. one foot in one minute.

2. A btu is defined as a British thermal unit. To convert heat to power, tests have been conducted which show that 42.44 btu per minute is equivelent to one horsepower.

3. In itself, the tractor is of little good to the farmer because it does not put the horsepower to work. Until some source of outlet for power is attached to the tractor, the horsepower is confined in the tractor. The attachment of a plow or such supplies a source of outlet.

4. a. Draw bar
   b. P. T. O.
   c. Driving members
   d. Hydraulic system

5. Indicated horsepower differs to brake horsepower because it does not take into consideration friction or other mechanical loss.

6. Conditions affecting the calculation of draw-bar horsepower are:
   a. Condition of ground
   b. The adhesion of the driving wheels to the ground
   c. The size of the driving wheels
   d. The packing of the ground

7. Indicated horsepower

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT Internal Combustion Engines

TOPIC Power Plant Construction and Terminology

1. Heart

2. Cylinder head piston

3. 1. Compression rings
   2. Scraper rings
   3. Oil ring
   4. Piston
   5. Piston pin
   6. Lock screw
   7. Connecting rod and cap
   8. Cap bolt
   9. Bearings
   10. Cap bolt nut
   11. Shim (if used)
   12. Cylinder liner
   13. Packing rings

4. The purpose of a cylinder liner is to prolonge the block life by making it possible to replace it when too worn to be rebored. This will cut down expenses.

5. 1. Core hole cover gasket
   2. Core hole plug
   3. Cap screw long
   4. Core hole cover
   5. Cap screw short
   6. Nut 3/8" diameter
   7. Washer 3/8" diameter
   8. Nut 1/2" diameter
   9. Intake valve guide
   10. Exhaust valve guide
   11. Exhaust valve seat
   12. Stud 1/2" diameter
   13. Stud 3/8" diameter
   14. Head gasket
   15. Cylinder head

6. 1. Flywheel
   2. Crankshaft
   3. Setscrew
   4. Pulley
   5. Front seal
   6. Timing gear
   7. Front bearing (half)
   8. Center bearing (half)
   9. Rear bearing (half)
   10. Rear seal (half)
   11. Oil wick
   12. Ring gear
   13. Cap Screw

7. 1. Bushing
   2. Rear plug
   3. Camshaft
   4. Tappet
   5. Push rod
   6. Front plug
   7. Timing gear
   8. Gear cap screw
   9. Thrust screw

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Answer Sheet for Test
on
POWER MEASUREMENT

1. a. Indicated horsepower
   b. Brake horsepower
   c. Drawbar horsepower

2. Btu stands for British Thermal Unit and is used to measure heat.

3. The drawbar horsepower will generally be from 1/2 to 2/3 of the brake horsepower.

UNIT Internal Combustion Engines
TOPIC Power Plant Construction and Terminology
(Answer Sheet continued)

8. 1. Cam
   2. Valve tappet
   3. Valve tappet guide
   4. Tappet adjusting screw
   5. Valve spring
   6. Valve
   7 Valve guide
   8 Water jacket

9. 1. Rocker arm
   2. Oil line
   3. Spring
   4. Cotter

10. 1. Transfer
    2. Drain cock
    3. Cylinder block
    4. Oil gage rod
    5. Bushing
    6. Relief valve plunger
    7. Relief valve spring
    8. Relief valve plug
    9. Gasket
    10. Front bearing cap
    11. Center bearing cap
    12. Front shim
    13. Shim
    14. Bolt
    15. Rear bearing cap
    16. Seal half
    17. Gasket
    18. Cap screw
    19. Seal retainer
    20. Expansion plug
    21. Bushing

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Answer Sheet for Test
on
POWER PLANT CONSTRUCTION AND TERMINOLOGY

1. Piston and parts, connecting rod and bearings, cylinder liner

2. Cylinder head, gasket and related parts

3. Crankshaft, flywheel, and related parts

4. Camshaft and related parts

5. The L-head valve assembly

6. Rocker arm assembly

7. Cylinder block and related parts

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Internal Combustion Engines

TOPIC: Power Plant Disassemble, Assemble, and Repair

1. Steam cleaning

2. a. Remove engine accessories
   b. Drain radiator and block
   c. Remove all radiator clamps and bases
   d. Remove radiator holding volts and radiator
   e. Remove external engine parts

3. Fuel pump and fuel injector

4. Observation of worn parts and broken or excessively worn parts

5. By cutting halfway through with a torch and splitting the remainder with a chisel; or cutting halfway through with a 1/4" drill and splitting the remainder with a chisel.

6. Some rods and rod caps are numbered, however, if they are not a center punch may be used to number each corresponding part alike.

7. Camshaft bushings

8. Twenty

9. The space or gap between the ends of the rings after they have been inserted into the cylinder.

10. The oil ring should be installed first with the level toward the top. The scraper ring should be installed in the second groove with the outside notch down, and finally the compression ring should be installed in the top groove with the inside notch up.

11. Toward the front of the block.

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Answer Sheet for Test
on
POWER PLANT DISASSEMBLE, ASSEMBLE, AND REPAIR

1. Remove spark plug in the number one cylinder and rotate the crankshaft until the piston almost reaches the top of the compression stroke. Insert the plug. Install the wire on the plug and in the distributor cap opening which the rotor in the distributor points to. Install the remainder wires in rotation and running them to the plugs according to the firing order.

2. With the socket end up.

3. To follow manufacturer's recommendations on sequence and torque pounds.

4. Oil

5. Rotate engine to bring number one cylinder to the top of its compression stroke and line up crankshaft pulley on flywheel timing marks. Turn the injector pump to proper timing mark and slide it into the block meshing the gears on the pump with those on the crankshaft.

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Lubricants and Lubricating Systems

TOPIC: Lubricants (Engine oils and their functions)

1. Body or viscosity is the thickness or resistance to flow.

2. It must be heavy enough at operating temperature to prevent metal to metal contact. If it is too heavy, it cannot penetrate close clearances.

3. Viscosity is the body of an oil or its resistance to flow. It is expressed as the number of seconds required for a certain quantity (60ml.) of the oil to flow through a hole of a specified size in a special instrument known as a viscosity meter.

4. Viscosity decreases as the oil is heated.

5. Oxidation resulting from the exposure of the hot oil to air in the crankcase.

6. Thinning effect of fuel dilution.

7. Main and connecting rod bearings, and wrist pins and pistons.

8. The bearings will "burn out" or seize.

9. Viscosity.

10. Prevent deposits of oil contaminants as they are formed and by holding them in minute dispersion (suspension) in the oil so that they are eliminated when the crankcase is drained.

11. Short periods of operation, light loads, rich mixtures, or excessive idling.

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Answer Sheet for Test
on
LUBRICANTS (ENGINE OILS AND THEIR FUNCTIONS)

PART I:

1. False
2. False
3. True
4. True
5. False

PART II:

1. Cooling
2. Viscosity
3. a. Build up of dust and dirt
    b. By-products of combustion such as soot, carbon, acidic by-products and condensed water vapor.
    c. Unburned fuel from blow-by fuel leaks. Wear metals and rust
    d. Water or antifreeze solution from internal leaks in the cooling lsystem.
4. Dilution effect of fuel

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Lubricants and Lubricating Systems

TOPIC: Lubricants: Crankcase-Oil Viscosity (Grade) and
Crankcase-Oil Type (Service Classification)

1. Society of Automotive Engineers

2. More fluid

3. Adapted to winter use

4. SAE: 5W, 10W, 20, 20W, 30, 40 and 50

5. Design of the lubrication system, clearances of moving parts, and loads the engine may be expected to handle.

6. Oil may be forced out from between the bearing surfaces allowing metal to metal contact, resulting in very rapid wear. High oil consumption may also result.

7. Hard cold weather starting, extra power required for oil circulation, poor lubrication of tight fitting bearings.

8. They are broad viscosity range oils which have been prepared from special base oils and an additive called a viscosity-index improve. They are not as readily affected by temperature changes as single-grade oils.

9. Four

10. American Petroleum Institute

11. ML - Motor Light
MM - Motor Moderate
MS - Motor Severe
DG - Diesel General
DM - Diesel Moderate
DS - Diesel Severe

12. ML

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Answer Sheet for Test
on
LUBRICANTS: CRANKCASE-OIL VISCOSITY (GRADE) AND CRANKCASE-OIL TYPE (SERVICE CLASSIFICATION)

PART I:

1. (3)
2. (4)
3. (4)
4, (2)
5. (4)

PART II:

1. Lower
2. a. Motor Light
   b. Motor Moderate
   c. Motor Severe
   d. Diesel General
   e. Diesel Moderate
   f. Diesel Severe
3. American Petroleum Institute
4. Four
5. Decreases

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Lubricants and Lubricating Systems

TOPIC: Lubrication: Gear Oils, Hydraulic Oils, and Lubricating Greases

1. Some crankcase and gear oils are of the same viscosity, therefore it was necessary to number them differently to avoid confusion.

2. SAE 75, SAE 80, SAE 90, SAE 140, SAE 250.

3. a. Regular Type Gear Lubricant
   b. Warm Type Gear Lubricant
   c. Mild Type Extreme Pressure (EP) Gear Lubricant
   d. Multi-Purpose Type Gear Lubricant (API Service GL4)

4. Regular type and multi-purpose type.

5. Tractor manufacturers sometimes provide a special oil that is different from those available under API Classification.

6. a. Operating the hydraulic implement control system
   b. Operating the hydraulic steering mechanism

7. a. Single-grade and multi-grade crankcase oils of various types
   b. Gear oils
   c. Hydraulic oil
   d. Special oils-supplied by tractor manufacturers for use with their particular tractors

8. a. Anti-oxidants that keep the oil from thickening
   b. Rust and corrosion inhibitors
   c. Prevent foaming
   d. Mild extreme pressure(EP) additives prevent rapid wear and scoring of the hydraulic pump and gears.

9. Multi-purpose grease

10. a. Rust inhibitors b. Anti-oxidants

UNIT: Lubricants and Lubricating Systems
TOPIC: Lubrication: Gear Oils, Hydraulic Oils, and Lubricating Greases
(Answer Sheet continued)

11.	Power Steering	Implement Control	Transmission	Differential
WD Allis-Chalmers Gasoline	None	20W ML	80EP	80EP
John Deere 2010 Gasoline	John Deere 303	John Deere 303	John Deere 303	John Deere 303
Ford 501 Gasoline	*Ford M-2C41	Ford M-2C41	80EP	80EP
Oliver 1800 Diesel	*	**10W ML	80	80

	Power Take-Off	Pulley Housing	Final Drive
WD Allis-Chalmers Gasoline	80EP	20W ML	80EP
John Deere 2012 Gasoline	John Deere 303	80	80
Ford 501 Gasoline	80EP	90EP	80EP
Oliver 1800 Diesel	80	**10W-30SAE	80

* Automatic Transmission Fluid -- Type A

** Mix Oliver 102 082-A oil additive with the recommended oil ratio of 16 parts oil to 1 part additive.

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Answer Sheet for Test
on
LUBRICATION: GEAR OILS, HYDRAULIC OILS AND LUBRICATING GREASES

PART I:

1. Gear oils
2. Regular
   Multi-Purpose
3. Implement
   Power steering
4. Multi-purpose
5. Rust inhibitors
   Anti-oxidants

PART II:

1. True
2. True
3. False
4. True
5. False

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Lubricants and Lubricating Systems

TOPIC: Lubricating Systems

1. a. Efficient in operation
   b. Reliable
   c. Trouble-proof
   d. Simple

2. a. Good quality lubricant
   b. Correct grade of lubricant

3. a. Cylinder walls and piston
   b. Piston pin
   c. Valves and valve-operating mechanism
   d. Crankshaft and connecting bearing
   e. Other moving parts such as fan, water pump, ignition mechanism, etc.

4. a. Simple circulating splash
   b. Internal force feed and splash
   c. Full internal force feed

5. A relief valve

6. Gear driven

7. a. An oil level indicator
   b. An oil pressure or circulation indicator

8. a. Bayonet type-stick type
   b. Test cocks, one for high level and one for low level

9. a. Too thin oil
   b. Lack of oil
   c. Oil too cold-too heary to flow
   d. Broken pump parts or oil lines
   e. Clogged oil screen or oil lines

10. Piston pumping action creates an uneven pressure in the crankcase, therefore some means must be present to keep the oil from being forced out of the crankcase joints or past pistons and into the combustion chamber. The breather may also serve as the oil-filler opening.

UNIT: Lubricants and Lubricating Systems
TOPIC: Lubricating Systems
(Answer Sheet continued)

11. a. Poor carburetor settings
    b. Excessive chocking
    c. Loose, badly worn piston rings

12. Controls and eliminates trouble caused by water and fuel vapors.

13. Reduce engine wear by removing foreign particles from the oil.

14. a. General operation
    b. Filtering principle
    c. Size
    d. Direction of flow
    e. Type of element

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Answer Sheet to Test
on
LUBRICATING SYSTEMS

PART I:

1. False
2. False
3. False
4. False
5. False

PART II:

1. Bayonet (stick) and test cocks
2. Gear
3. Circulating splash
   Combined splash and force feed
   Full internal force feed

4. Cotton wastes
   Cellulose
   Replaceable elements

5. Relief valve

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Fuel Systems

TOPIC: Fuels and Principles of Combustion

1. a. Reasonably high energy value
   b. Vaporize at comparatively low temperatures
   c. Fuel vapor must ignite and burn readily when mixed in the proper proportions with oxygen.
   d. Not unduly harmful or dangerous to human health or life
   e. Can be handled and transported with comparative ease and safety.

2. a. According to physical state before entering engine cylinder, either gasous or liquid
   b. According to origin of fuel either natural or artificial

3. a. Gasoline
   b. Diesel
   c. Liquefied petroleum

4. a. From dry gases and gasoline as it is removed from crude oil
   b. From recycling plants from the wet gas
   c. From the normal processing of crude oil into commercial gasoline and distillates

5. a. Gasoline
   b. Kerosene
   c. Distillate
   d. Diesel fuels

6. The ability of a liquid to change to a vapor

7. a. White or fourth grade
   b. Regular
   c. Premium
   d. Super-premium

UNIT: Fuel Systems
TOPIC: Fuels and Principles of Combustion
(Answer Sheet continued)

8. Detonation is the "knock" caused by higher compression pressurer, whereas preignition is the firing of the fuel change too far ahead of the compression dead center position of the piston.

9. Combustion is the chemical union of the fuel with oxygen. In an internal combustion engine this union gives off intensive heat and produces an oxide. These gases being confined in a very small place, produce high pressures and consequently exert a greater force on the piston and thus generate power.

10. The ability of a gasoline to resist detonation.

11. Diesel fuels are graded by the American Society for testing materials into two grades. Number 1 Diesel Fuel (NO. 1-D) and number 2 Diesel Fuel (NO. 2-D). They are graded on the basis of the centane number, and the maximum limits of impurities such as water sulfur, sediment, etc.

12. Centane rating is a measure of the self ignition and burning qualitites of diesel fuel of which anti-knock is one quality.

13. The two worst enemies of diesel fuel is sulphur and water.

Vocabulary:

Destillate - crude oil products greatly resembling kerosene but having a different color and odor.

LP gas - liquedified petroleum so named because they turn to gas at atmospheric pressure and temperature. More or less a by-product of the petroleum refining process.

Detonation - the "knocking" effect caused by fuel in high compression engines after ignition has taken place.

Preignition - the noise made when fuel is ignited too far ahead of compression dead center of the piston.

Combustion - the chemical union of fuel and oxygen causing force to be applied to the piston thereby producing power.

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Answer Sheet for Test
on
FUELS AND PRINCIPLES OF COMBUSTION

1. a. Gasoline
   b. Kerosene
   c. Distillate
   d. Diesel

2. a. Sulphur
   b. Gum

3. 10 parts air to 1 part fuel, to 20 parts air to 1 part fuel

4. 2:1

5. 15:1

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Fuel Systems

TOPIC: Gasoline Systems

1. Mix and deliver the proper air-fuel mixture to the engine.

2. In a cold engine the air-fuel ratio should be about 9 to 1, whereas the ratio in a hot engine should be about 15 to 1. In extremely cold engines the choke may provide a mixture as rich as 2 to 1.

3. a. The fuel supply system
   b. The idling system
   c. The load system
   d. The choke or starting system

4. Updraft and downdraft

5. To deflect hot exhaust gases around the intake manifold to assist in vaporizing the fuel droplets entering the engine

6. Place a small rubber and glass tube device to the bottom of the carburetor and then run it upright along the side of the carburetor float bowl. The liquid in the tube will then seek the same level as that in the float bowl. Engines having fuel pumps should be running when this test is made.

7. First, you would adjust the idle speed adjustment screw. This is done by closing the throttle until the engine runs at a fast idle. Then turn in the idle speed adjustment screw until the engine begins to increase speed. Close the throttle completely and re-adjust the needle turning it out until engine reaches the idle speed you want. (approximately 425 rpm.)

8. First, bring the engine to normal operating temperature and then by turning the adjustment screw counterclockwise set the carburetor for the type work to be done -- light or heavy. It is always best to consult the operator's manual for exact settings.

UNIT: Fuel Systems
TOPIC: Gasoline Systems
(Answer Sheet continued)

9. The venturi is a narrowing of the throat of the carburetor causing somewhat of a restriction. Its purpose is to increase the velocity of the air entering the carburetor. This is to create a partial vacuum at the discharge nozzle in order to get better fuel to air mixture.

10. A float and needle valve is used to maintain a constant fuel level. This is important in order to obtain a uniform discharge of fuel.

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Answer Sheet for Test on GASOLINE SYSTEMS

1. Updraft and downdraft refer to the direction of wind travel through the carburetor whether up or down.

2. A venturi is a narrowing of the carburetor throat causing somewhat of a restriction.

3. a. Fuel supply system
   b. Idling system
   c. Load system
   d. Choke or starting system

4. Bring the engine to normal operating temperature and then close the throttle to cause the engine to run at a slow idle. Turn the idle adjustment screw in until the engine begins to increase speed. Close the throttle completely, and then turn the idle adjustment screw out until the engine slows to the desired speed. (approximately 425 RPM)

5. a. Quicker engine warm up
   b. Increased fuel economy
   c. Reduction of cylinder wall wear

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Fuel Systems

TOPIC: LP Gas Systems

1. Because, propane has a lower boiling pint than butane and thereby insures vaporization at extremely low temperatures.

2. In the winter straight butane will loose its pressure at 32° F. whereas propane will retain approximately 54 pounds pressure at 32°F. In the summer butane will have only 32 pounds pressure at 100° F., whereas propane will have 195 pounds pressure at 100°F. For these reasons a mixture of the two fuels ranging from high propane concentraion in winter to high butane concentration in summer is used to maintain a fairly constant pressure.

3. They are of the same general type and make-up, however, the LP may have a slightly higher compression ratio ranging up to 9:1. The big difference is in the handling and utilization of the fuel. In this type engine the fuel goes from the storage tank through a filter in the high pressure regulator. Here, the pressure is reduced to about 8 pounds per square inch and partial expansion and vaporization begins. The fuel then enters the vaporizer coils, which is surrounded by heated water from the engine cooling system, and further expansion and vaporization occur. This vapor then passes through the low pressure regulator which reduces the pressure slightly below atmospheric. From here the fuel goes to the carburetor where it is mixed with air before entering the cylinder. It also takes a different type carburetor.

4. Less wear due to burning clean, leaving no deposits
   A high anti-knock characteristic

5. Gasoline has the greatest potential power having a heat value of 124,000 btu's per gallon compared to 91,500 to 103,500 btu s per gallon on propane and butane respectively. Assuming that the engine will have the same thermal efficiency when using either fuel, we will see that gasoline will have the greater horsepower hour out put.

UNIT: Fuel Systems
TOPIC: LP Gas Systems
(Answer Sheet continued)

6. Storage problems and costs
   Lower btu rating

7. a. The LP gas engine carburetor has no fuel float and storage chamber since thefuel enters the carburetor as a gas.
   b. There is no venturi since LP gas and air mix readily
   c. The choke on some models works opposite to that on the gasoline engine. Rather than shutting off the air, it shuts off fuel.

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910-IV-3

Answer Sheet for Test
on
L. P. GAS SYSTEM

1. False

2. True

3. True

4. False

5. True

6. False

7. False

8. True

9. True

10. True

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Fuel Systems

TOPIC: Governors

1. a. Hit and miss system
   b. Throttle system

2. To maintain constant engine speed whether under load or running free.

3. The fluctuating of engine speeds caused by the governor.

4. It is caused by incorrect carburetor settings or by the governor being too stiff or by striking or binding so that it fails to act freely.

5. A vacuum or automatic type.

6. The hit and miss system is adapted only to slow speed engines. It keeps all explosions alike and at the maximum intensity, but varies the number per time interval depending upon the power out put required. This is achieved by weights on the flywheel which tend to spread apart as speed increases. This expansion slides a collar on the shaft which reacts on one end of the pivoted detent arm causing the opposite end to catch in a notch on the exhaust valve holding it open. This valve being held open will not allow a fuel charge to be drawn in, compressed and fired, thereby slowing the engine down.

7. The principle of the throttle system of governing is to permit the engine to fire the maximum number of times but to regulate the fuel charge per cycle thereby slowing the engine down. This is done by a set of weights on the shaft which are held together by springs. As the engine builds up RPM's the weights fly apart, moving a sliding collar and actuating a throttle connecting rod causing the throttle butterfly to partly close thereby cutting off the fuel mixute. As the fuel mixture is decreased, the engine slows down.

8. The throttle governing system.

9. For slow speed single cylinder engines.

UNIT: Fuel Systems
TOPIC: Governors
(Answer Sheet continued)

10. The vacuum type governor is located between the carburetor and intake manifold. It consists of a housing and a throttle-butterfly valve mounted off center and connected to a spring controlled cam and lever mechanism. As the pressure of the gas being drawn into the engine increases the off center mounted butterfly tends to close, thereby maintaining a constant speed.

11. Diesel engines are governed by the weight or fly ball systsm. As the weights on the governor begin to change positions it moves a geared rack which rotates the scroll and supplies the correct amount of fuel.

12. On air cooled engines the vane-type method of governing is used. As the engine speed increases, the vane is forced by air toward a closed position. The throttle spring then takes over holding the valve at whatever position the throttle is set.

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910-IV-4

Answer Sheet for Test
on
GOVERNORS

1. F

2. T

3. T

4. T

5. F

6. F

7. F

8. T

9. T

10. F

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Fuel System

TOPIC: Diesel Fuel Systems - Principles of Operation, Combustion Chamber, Air Systems, and Starting Aids

1. Review taken from required texts.

2. Combustion is caused by the rising temperature of the compressed air which reaches a temperature of 1000°F. to 1100°F.

3. On the intake stroke of a diesel only air is brought into the combustion chamber whereas both fuel and air is drawn into the carburetor type engine.

4. The fuel is injected under pressure by the fuel injector into the pre-compressed air.

5. Ignition takes place immediately upon injection due to the temperature of the air.

6. Cleanliness is extremely important due to the extremely precisioned machined parts in the injection system.

7. In the diesel engine the compression ratios range up to twice that of the gasoline or LP gas engines. Also, the heat range is much higher making it necessary to increase the amounts and materials of construction.

8. On a two stroke, diesel air is pumped into the cylinder by a blower mounted in line with the intake port.

9. A diesel may be started by the following ways:
   a. A small auxiliary engine may be used.
   b. A dual fuel system may be used.
   c. Direct starting on diesel fuel by use of 24 volt electrical system to turn motor.

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Answer Sheet for Test
on

DIESEL FUEL SYSTEMS-PRINCIPLES OF OPERATION, COMBUSTION CHAMBER, AIR SYSTEMS AND STARTING AIDS

1. 14:1 to 20:1

2. 1200° F. - 1500° F.

3. It is more important because the fuel injection nozzle has very small openings to allow the fuel to enter the cylinder. These are machined to as small as .0003 inch and will stop up very easily.

4. No

5. Heat from compressed air.

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Fuel Systems

TOPIC: Diesel Fuel Systems, Injection Pump and Fuel Injectors

1. Always work in extremely clean conditions and avoid getting any foreign material in a filter unit.

2. a. Fuel tank
   b. Low pressure line where filters are located
   c. Injection pump
   d. High pressure line (on some)
   e. Injectors
   f. Return fuel line (on some)

3. To apply very high pressure to the fuel from 2400 psi to as high as 20,000 psi.

4. This high pressure is used by the injector nozzles to make a fine mist of the fuel as it is sprayed into the cylinders. This provides for an immediate and even mixture with air in the cylinder for even burning.

5. The return fuel line returns excess fuel from the injectors or from the injection pump or both to the fuel tank depending upon the design of the injectors.

6. A filter is for the purpose of removing moisture and dirt particles from the fuel. The first stage filter removes most of the water and coarse material, the second stage filter removes the finer particles and a small amount of water. If a third stage is used, it is intended to remove any remaining smaller particles.

7. The number of filters used is a matter of judgement on the part of the manufacturer.

8. First stage may be called the primary or auxiliary filter, the second stage may be called the intermediate and the final stage is known as the final filter.

UNIT: Fuel Systems
TOPIC: Diesel Fuel Systems, Injection Pump and Fuel Injectors
(Answer Sheet continued)

9. a. Edge-type metal filter
   b. Yarn-type filter
   c. Filter element (usually a paper filter) contained within a perforated can
   d. Filter element (usually a paper filter) contained within its own outside casing
   e. Sealed-type paper filter (often used for final stage)

10. If fuel lines are not bled, the air trapped in the new filter may cause an air lock causing your tractor to fail to start or to run improperly. The filter nearest the fuel tank should be drained first and right down the line.

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Answer Sheet for Test
on
DIESEL FUEL SYSTEMS, INJECTION PUMP AND FUEL INJECTORS

1. T
2. T
3. T
4. T
5. T
6. F
7. F
8. T
9. F
10. F

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910-IV-6

Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Fuel Systems

TOPIC: Air Cleaners

1. a. The dry type
   b. The oil soaked element type
   c. The oil bath type

2. One located 30" above the dash of the tractor

3. a. It must effectively remove dust, but not restrict unduly the carburetor intake
   b. Must work successfully in all climates
   c. Require only minimum attention from the operator
   d. Sturidly built

4. The dry type oil filter utilizes two principles; one being a rapid change in direction to cause large particles of air to fallout and another the swirling of the air to cause large particles to be thrown out by centrifugal force. After the air is cleaned in this manner, it then passes through a pleated paper filter designed to allow the air to pass through but stop dust particles. This paper is often chemically treated to aid in the filtering of the air. This system is 99% effective and is often used as a pre-cleaner.

5. The oil bath unit also utilizes the principle of reversing the direction of air travel. The air is drawn down a tube until it strikes oil held in a small reservoir at the bottom. As the air strikes the oil, the impact causes a mixture of oil spray and air to be carried upward into a separating element consisting of a system of baffels and metal mesh. The separating elements cause the dust laden air to be broken into fine air streams and change directions many times. Dust will be trapped by the oil film and gradually returned to the reservoir.

UNIT: Fuel Systems
TOPIC: Air Cleaners
(Answer Sheet continued)

6. The oil soaked element is very simple in operation. The element is placed in the path of travel of the air and as the air strikes it, the oil on the filter element holds the dust and allows the clean air to continue its travel.

7. a. The oil bath filter is cleaned by removing the bowl and washing it in a good solvent, replacing the oil with correct grade and amount according to the operator's manual direction.

   b. The oil soaked element is cleaned by removing the element, washing it in tractor fuel, drying it and then dip in fresh oil. Also, wipe all dust out of the filter itself.

   c. The dry filter is cleaned by removing the element and tapping it gently to remove the remaining particles. In the case of a precleaner, empty all loose dust particles and wipe the container clean with a clean rag.

8. The air intake tube, all pre-cleaners and screens and engine breather caps.

9. Daily or more often in extremely heavy dusty work.

10. a. Around worn parts of the carburetor
    b. Places where gaskets are missing
    c. In drain holes in carburetors
    d. Damaged filter elements
    e. Loose connections

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Answer Sheet for Test
on
AIR CLEANERS

1. A farm tractor requires about 9000 gallons of air for each gallon of fuel burned. If this air is not clean the engine will wear out in a very short time, approximately, a few hundred hours.

2. It is too flammable.

3. No, because the engine may have some gaskets, connections or missing parts which will allow dust to enter.

4. The use of an air cleaner will lengthen the life of the engine as well as provide for better performance.

5. The service manual will give you information as to how often the filters should be changed, how specific brands should be cleaned and the replacement unit identification numbers.

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Fuel Systems

TOPIC: Intake and Exhaust Manifold and Pipes

1. The purpose of the intake manifold is to conduct the fuel and air mixture from the carburetor to the engine cylinders.

2. Yes, copper-asbestos gaskets are necessary because of the extreme heat.

3. The intake manifold gasket seals out air impurities and seals in the fuel air mixture so that the engine will perform properly.

4. To help eliminate a fire hazard, cut down on noise and assist in removing exhaust fumes.

5. The intake manifold is designed to prevent the inertia of the mixture from loading up one cylinder and to give equal mixture in each cylinder.

6. Back pressure in the engine reduces performance and may cause valve trouble.

7. Replace mufflers with factory recommended units and be sure all connections are tight.

8. Inertia is the movement of the air-fuel mixture in a uniform motion in the same straight line going to the same cylinder unless acted upon by outside forces.

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Answer Sheet for Test
on
INTAKE AND EXHAUST MANIFOLDS AND PIPES

1. The purpose of the intake manifold is to bring the fuel air mixture from the carburetor to the cylinder, keeping it mixed.

2. Inertia is the movement of the air-fuel mixture in a uniform motion in the same straight line going to the same cylinder unless acted upon by forces.

3. Back pressure in the engine will cause lower engine performance.

4. Gaskets are necessary in the manifold system to keep down fire hazards and hazardous fumes of the exhaust system and to prevent improper fuel-air mixture and foreign matter from entering the engine.

5. The exhaust manifold supplies hot fumes to preheat the air-fuel mixture entering the cylinder from the intake manifold.

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Cooling Systems

TOPIC: Liquid and Air Cooling Systems

1. 175°

2. From water jacket to radiator, down radiator to bottom and back up through the water jacket from bottom to top.

3. Thermo-siphon and forced circulation

4. As the water flows down through the radiator, the heat is transferred from the water to the metal in the radiator. The fan pulls air through the radiator thereby transferring the heat into the air stream.

5. The thermostat blocks the flow of water into the radiator thereby allowing the engine to heat up to normal operating temperature more rapidly. When the normal operating temperature is reached, the thermostat will open allowing the water to pass on through the opening and into the radiator.

6. No. The thermo-siphon system operates on the principle that as water is heated, it becomes lighter and as it moves up, cooler air from the radiator will take its place. This hot air will rise and finally enter the top of the radiator. As it does, the air will cool, thereby becoming heavier and settle to the bottom of the radiator thereby completing a cycle.

7. The water pump is to speed up cooling by speeding up circulation.

8. Diesel - 145°-165°
   Tractor fuel - 190°

9. With each pound of pressure the boiling point is increased 3°F.

10. This system forces air past the hottest part of the engine block and cylinder head. Sheet metal shrouds are often used to direct the flow of air. The air is usually forced through the system by a fan which is usually a part of the bly wheel.

UNIT: Cooling Systems
TOPIC: Liquid and Air Cooling Systems
(Answer Sheet continued)

11. a. An accumulation of leaves or chaff on the radiator
    b. An overload on the engine
    c. Insufficient water in the cooling system
    d. Excessive lime deposits in the cooling system
    e. Carburetor out of adjustment (usually too clean)
    f. Ignition out of time
    g. Loose fan belt
    h. Use of a fuel too low in anti-knock quality for the engine

12. Because, it does not have the heat carrying capacity that water has.

13. No.

14. Near the outlet of the cylinder head

15. 300 hours

16. a. Excessive wear
    b. Warpage and cracking of engine parts (particularly heads)
    c. Burning of valves

17. a. Increase fuel consumption
    b. Excessive wear (due to inadequate oiling)
    c. Lower horsepower

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Answer Sheet for Test
on
LIQUID AND AIR COOLING SYSTEMS

1. Air and liquid

2. Thermo-siphon and forced circulation

3. a. Excessive wear
   b. Excessive fuel utilization
   c. Loss of power
   d. Burning of valves
   e. Warpage and possible cracking of engine parts

4. Gasoline - 175°
   Diesel - 145°-165°
   Tractor fuel - 190°

5. Near the outlet of the cylinder head

6. The air is forced around the fins of the engine by use of a sheet metal shroud and a fan made on the flywheel. This air takes the heat from the hot engine parts, thereby cooling them.

7. The boiling point of water is raised 3°F. for every pound of pressure.

8. It will cause bearings to wear out quicker causing the water pump to leak.

9. Every 300 hours

10. Remove it from the engine, place it in water 20° hotter than the temperature marked on the thermostat. The valve should open at this temperature. Then place it in water 10° cooler than the temperature marked on the thermostat and it should close. If it doesn't open or close properly, discard it and install a new one.

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Electrical Systems

TOPIC: Magneto System

1. The rotation of the armature of the magneto

2. This construction simplifies design, reduces size, and lowers the cost.

3. Just before a reversal of the magnetic flux.

4. Rotation of the magnetic rotor causes the magnetic flux to flow through the frame laminations and induces a flow of current in the primary windings.

5. To absorb the surging current when the points are opened and thus prevent arcing and burning of the points.

6. The storage action of the condenser is followed by a quick and complete collapse of the magnetic field then existing in the coil. This collapse induces a secondary current which is much higher voltage due to the more turns of a wire in the secondary circuit.

7. One and one-half times the engine speed.

8. A device used to give the magneto a quick flip to assist in starting. It consists of weighted pawls and a spring arrangement which wind up as the cranking begins. The spring gives the armature or rotor a quick flip which produces a hot spark.

9. On non-sealed units a very small amount of light machine oil may be used as recommended by the manufacturer or bearings or gears. If the impulse coupling becomes sluggish, it should be flushed with kerosene and reoiled. The distributor should be kept clean as possible and the points should be regapped or replaced every 200-300 hours.

10. One must be careful not to rotate the distributor arm because on many late models the gear case can be replaced with the distributor arm rotated one-half turn.

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Answer Sheet for Test
on
MAGNETO SYSTEMS

1. True
2. False
3. False
4. True
5. True
6. True
7. True
8. False
9. True
10. True

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910-VI-2

Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Electrical Systems

TOPIC: Introduction to the Battery Ignition System

1. Provides a hot spark at the spark plug--the job of the ignition coil.

   Times the spark so that it occurs at the right instant to ignite the fuel in the cylinder--the job of the distributor.

2. The opening and closing of the breaker points in the distributor

3. The rotating cam is powered by the engine cam shaft to which it is geared.

4. It flows from the battery through the primary winding of the ignition coil, to the distributor and to the ground connection where it returns to the battery.

5. A "ground" provides a path for the current to return to its source. In the case of the ground for the primary circuit the current is conducted through the metallic parts of the engine back to the battery ground connection.

6. Energizes the ignition coil

7. The cam lobe in the distributor turns enough to open the breaker points which breaks the primary circuit.

8. To jump the spark plug gap

9. Ignition coil through the distributor rotor, along the wire leading to the spark plug, where it jumps the gap and ignites the fuel in the cylinder. It then passes through the ground electrode of the spark plug, back through the shell of the engine to the ground connection of the ignition coil.

10. The condenser prevents sparking by providing a place where the current can flow until the points are safely separated. The condenser also helps collapse the flux lines more quickly, thus causing a higher secondary voltage.

UNIT: Electrical Systems
TOPIC: Introduction to the Battery Ignition System
(Answer Sheet continued)

11. Battery, ignition coil, distributor, spark plugs, along with necessary wiring

12. Distributor cap, rotor, distributor shaft, cam, breaker points, and the condenser which is housed in the distributor.

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Answer Sheet for Test
on
BATTERY IGNITION SYSTEMS

1. 1/000 TW of a second

2. a. Generator circuit
   b. Starting circuit
   c. Lighting circuit
   d. Ignition circuit

3. a. 3600
   b. 900
   c. 5400
   d. 324,000

4. Easier starting

5. Electromagnetic induction

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910-VI-3

Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Electrical System

TOPIC: The Battery

1. a. Positive plates
   b. Negative plates
   c. Separators
   d. An electrolyte
   e. Case or container

2. Hard rubber or bituminous composition

3. At 0°F. a charged battery will be about 40% efficient whereas the same battery at 80°F. will be about 100% efficient.

4. About 2 volts per cell

5. It is weak, very diluted, almost water.

6. As the current is used, both the lead spouge and lead peroxide are covered with lead sulphate by chemical action.

7. A battery is charged by reversing the chemical action by passing a direct current of proper voltage through the battery. This current removes the sulphate from the plates returning it to the acid electrolyte.

8. Mix soda and water into a thick paste and spread on corroded parts. Let this solution stand on the parts for a few minutes, then wash with clear water.

9. When charging a battery, it will give off a highly explosive gas; therefore, it is necessary to keep all spark or open flames away from the battery.

10. The charge is checked by the use of an hydrometer which tells the specific gravity of the electrolyte. This specific gravity shoud be 1.285 for a full charged battery.

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Answer Sheet to Test
on
THE BATTERY

1. T
2. T
3. F
4. F
5. F
6. T
7. F
8. T
9. T
10. T

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Electrical System

TOPIC: Generators, Alternators, and Accessories

1. To supply enough current to take care of all electrical equipment and to keep the battery fully charged.

2. The same as that of the generator.

3. To regulate the current entering the battery so that the battery will remain fully charged but will not overcharge.

4. To keep the battery from discharging back through the generator.

5. a. Voltage regulator
   b. Manual switch
   c. Use of the third brush

6. The manual switch is used to insert or remove an electrical resistance in the generator field circuit. When the resistance is in the field, the rate of charging is reduced. When the switch is closed, the resistance is by-passed and the charging rate is increased.

   The third brush is often used to regulate the generator output. As the third brush is moved toward the main brush in the direction of travel of the armature, the output is increased. As it moves toward the main brush against the direction of travel of the armature, the output is reduced.

   The voltage regulator is used on most modern farm tractors today. It controls the generator output by automatically opening and closing the contact points within the regulator. As the current flows from the generator to the battery, the contact approaches full charge and the voltage increases causing the points of the regulator to open. This action causes the generator field current to flow to the ground through increased resistance, lowering its voltage.

UNIT: Electrical System
TOPIC: Generators, Alternators, and Accessories
(Answer Sheet continued)

7. A generator develops direct current where an alternator develops alternating current which is rectified or changed into direct current in the alternator by use of diodes.

8. The ammeter is used to indicate the flow of current from the generator to the battery on the flow side or the flow of current from the battery to lights and other electrical accessories on the discharge side. It also indicates whether or not the generator is functioning properly.

9. The bearings may need oiling with a light oil several times during the year; however, oil should be used sparingly because excessive amounts may get into the windings and cause damage. Also, the commutator may become corroded. To do this, No. 00 sandpaper may be held against it as the engine turns slowly.

10. It will serve as a conductor and might short the commutator segments.

11. Ground across the battery and generator terminal post on the voltage regulator momentarily.

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Answer Sheet for Test
on
GENERATORS, ALTERNATORS AND ACCESSORIES

1. Brush seating stone or sandpaper No. 00

2. Repolarize it

3. a. Automatic voltage regulator
   b. Third brush
   c. A manual switch

4. That it has been overheated and may need attention

5. Direct
   Diodes

6. The generator produces electrical energy to run the engine, charge the battery and take care of all the electrical needs of the tractor

7. Remove the drive belt and hold the cutout points closed. If the generator is still in working order, it will turn slowly like an electric motor. During this test the ammeter should not read over 2-4 amps discharge.

8. The brushes pick up the current from the commutator.

9. The ammeter

10. That the brushes should never be set closer than 3. 2 commutator bars.

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Electrical System

TOPIC: Starters

1. Both have commutators, both are constructed very much alike having an armature, field coil, brushes, and bearings.

2. The starter has heavy wiring so it can draw a large amount of current for short periods of time where the generator uses smaller wire. It also has a special gear drive, cushioned with a spring to engage the flywheel.

3. It may be cleaned exactly like a generator with No. 00 sandpaper or a brush seating stone.

4. The starter motor is equipped with a bending drive which moves against the flywheel ring gear and engages the teeth on the gear and thus turns the engine. When the engine turns faster than the starter armature, the bendix automatically disengages.

5. The starter draws a very heavy current and will discharge the battery very quickly.

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Answer Sheet for Test
on
STARTERS

1. Heavy
2. Flywheel ring gear
3. Electric
4. The speed of the flywheel exceeds that of the starter.
5. No. 00 sandpaper or a brush seating stone
6. Burning up
7. Solenoid
8. Clean and tight

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Engine Testing and Tune Up

TOPIC: Timing the Ignition System

1. a. The breaker point method b. The timing light

2. Proper timing means that the ignition is set so the distributor will supply a spark to each cylinder at a time when the fuel will burn with the greatest efficiency.

3. On the flywheel or fan pulley

4. One lead goes to the number one plug wire while the other goes to a good ground.

5. One lead goes to the No. 1 spark plug wire while the other 2 go to the battery cables.

6. Loosen the plug, pull the center wire out of the soil, and turn the engine over and listen for a hissing sound. This will indicate the compression stroke.

7. The timing light should be held directly over the timing marks because holding it at an angle can cause the timing to be off.

8. When the timing marks are on TDC(top dead center) the breaker points should be just beginning to open.

9. Always go to the service manual of the make and model of that engine and get the correct information.

10. Retarded timing is the setting of the breaker points so that the spark reaches the spark plug after top dead center whereas, advanced timing is the spark reaching the plug just ahead of top dead center.

11. A diesel is timed by adjusting the injection pump to start the injection at just the right time. In most cases this is so that the full pressure of the fuel charge exerts its pressure in the first 90° of crank travel.

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910-VII-1

Answer Sheet for Test
on
TIMING THE IGNITION SYSTEM

1. False
2. True
3. True
4. False
5. False

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910-VII-2

Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Engine Testing and Tune-Up

TOPIC: Valve Clearance Adjustments

1. a. Tappet adjustment
   b. Valve adjustment
   c. Valve spacing
   d. Valve lash

2. The provision for proper clearances between the ends of the rocker arms and the ends of the valve stems during the time that the valves are not being depressed.

3. Exhaust and manifold or intake.

4. a. To give longer service
   b. Better engine efficiency
   c. Easier starts
   d. Maximum power
   e. Cooler engine operation
   f. Smooth engine operation

5. Some valves are adjusted with the engine hot while others are adjusted with the engine cold. Always check the operator's manual to see how the engine should be adjusted.

6. a. Proper sized hex end wrench
   b. Proper sized open end wrench
   c. Leaf thickness gage(feeler gage)
   d. Svrew driver

7. Between the rocker arm and the valve stem

8. This rocker arm is for fuel injection.

9. The critical area is between the valve seat and the face of the valve.

10. By turning them up on a smooth surface and checking the height of each. Those that are weak will be shorter.

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Answer Sheet for Test
on
VALVE CLEARANCE ADJUSTMENTS

1. Exhaust

2. Rocker arm and valve stem

3. Performance

4. Tappet adjustments, valve lash, tappet, valve spacing or valve adjustments.

5. Operator's manual

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Hydraulics

TOPIC: Introduction

1. Hydraulics may be defined, in a strict sense, as the science of fluid forces.

2. Pascal

3. a. Simplicity in design
   b. Extreme flexibility as regards to location of components
   c. Complete automation of sequence is possible.
   d. Simplicity of speed control
   e. Limitless variety of speeds, controls, and forces
   f. Reduction of wear on moving parts by:
      1. Controlled acceleration and deceleration
      2. Automatic release of pressure at overload
      3. Absence of vibration
      4. Automatic lubrication
   g. Efficient and economical to operate
   h. Large forces can be controlled by much smaller ones.
   i. Power and friction losses are comparably small.

4. a. Pressures often are very high. 2 or 3,000 lbs. per sq. in. is not uncommon. High pressures require heavy tubing, tight joints, and intelligent maintenance.
   b. Operating efficiency can be severely reduced, or operation halted, by rust, corrosion, high temperatures, dirt, and the products of fluid deterioration. Cleanliness is all-important.

5. The fluid is incompressibility
   Multiplication of forces
   Hydrostatic and hydrodynamic power

6. Define:
   a. Hydrostatic Power - is where the potential (static) energy of fluid under pressure is used to perform work.

UNIT: Hydraulics
TOPIC: Introduction
(Answer Sheet continued)

b. Hydroynamic - where the Kinetic (dynamic) energy of fluid in motion is used to perform work.

7. a. Reservoir
   b. Pump
   c. Return line
   d. Pressure line
   e. Relief valve
   f. Directional control valve
   g. Cylinder

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Answer Sheet for Test
on
INTRODUCTION

1. a. Reservoir
   b. Pump
   c. Return line
   d. Pressure line
   e. Relifel Valve
   f. Directional control valve
   g. Cylinder

2. Pascal's law states that pressure applied at any point in a static fluid is the same in all directions and acts with equal force on equal areas.

3. Hydraulics may be defined, in a strict sense, as the science of fluid forces.

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Hydraulics

TOPIC: Reservoirs

1. The size of the reservoir depends on the amount of fluid required to operate the system. An ideal size is 2 or 3 times the capacity per minute of the pump.

2. a. So it can hold all the fluid that drains back into the reservoir by gravity flow.
   b. So it can maintain the fluid level above the opening of the suction line at all times.
   c. So it can dissipate excess heat generated during normal operation.
   d. So it can allow air and foreign matter to separate from the fluid.

3. a. Filler strainer
   b. Return line
   c. Air filter
   d. Outlet to pump
   e. Dipstick
   f. Drain plug
   g. Cleanout opening
   h. Pump intake filter
   i. Baffle

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Answer Sheet for Test
on
RESERVOIRS

1. True
2. False
3. False
4. True
5. True

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Hydraulics

TOPIC: Hydraulic Pumps

1. a. Fixed delivery when running at a given speed.
   b. Variable delivery when running at a given speed.

2. Fixed delivery

3. a. Reciprocating pumps
   b. External gear pumps
   c. Internal gear pumps
   d. Gear-like pumps
   e. Screw pumps
   f. Vane pumps
   g. Radial piston pumps
   h. Axial piston pumps
   i. Centrifugal pumps
   j. Combination pumps

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Answer Sheet for Test
on
HYDRAULIC PUMPS

1. True

2. True

3. True

4. False

5. True

6. False

7. True

8. True

9. False

10. True

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Hydraulics

TOPIC: Hydraulic Valves

1. a. Directional control
   b. Volume control
   c. Pressure control

2. a. Mechanical
   b. Electrical
   c. Pneumatic
   d. Hydraulic
   e. Manual

3. a. Cock valve
   b. Glove valve
   c. Gate valve
   d. Flapper valve
   e. Ball valve
   f. Needle valve
   g. Spool valve
   h. Rotary valve
   i. Directional poppet valve
   j. Comernition of valves
   k. Flow control and flow divides valve

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910-XII-3

Answer Sheet for Test on HYDRAULIC VALVES

1. T

2. T

3. F

4. T

5. T

6. T

7. F

8. T

9. T

10. T

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Answer Sheet
for
AGRICULTURAL-MACHINERY MECHANICS

UNIT: Hydraulics

TOPIC: Hydraulics Cylinders

1. a. Single action
   b. Double action

2. a. A thermal safety valve, set far higher than system pressure, to relieve any pressures caused by thermal expansion while the system is at rest.
   b. Using a double-walled cylinder.
   c. Stroke control valves which are adjustable to stop the cylinder at any point in its travel, by shutting off the flow of fluid to the cylinder, or otherwise closing a valve.
   d. In some cases, the cylinder moves, and the piston is fastened to the base.
   e. Another refinement is the telescoping piston.

3. The hydraulic cylinder turns fluid under pressure into a work force.

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Answer Sheet for Test
on
HYDRAULIC CYLINDERS

1. True
2. True
3. True
4. True
5. True

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Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Hydraulics

TOPIC: Hydraulic Seals and Packings

1. a. Static- Used as a gasket to seal non-moving parts
   b. Dynamic- Used to seal moving parts

2. a. Cup packing
   b. Flangs packing
   c. U-packing
   d. V-packing
   e. Expanding metallic seal
   f. Non-expanding metallic seal
   g. Mechanical seal
   h. Compression packing
   i. Spring-loaded lip seal
   j. O-Ring

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Answer Sheet for Test
on
HYDRAULIC SEALS AND PACKINGS

1. a. Cup packing
   b. Flange packing
   c. U-packing
   d. V-packing
   e. Expanding metallic seal
   f. Non-expanding metallic seal
   g. Mechanical seal
   h. Compression packing
   i. Spring-loaded lip seal
   j. O'Ring

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# Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Hydraulics

TOPIC: Hydraulic Lines and Fittings

1. a. Copper
   b. Steel
   c. Standard iron

2. Galvanized pipe should never be used, as it is likely to "flake" and these metal chips will cause serious damage.

3. The bending radius of tubing and pipe is ideally not less than three times the I. D. of the tube.

   The bending radius of flexible hose should be less than six times the inside.

4. a. Sleeve coupling for flexible hose
   b. Flexible hose coupling
   c. Flareless (Bite-type) coupling
   d. O-Ring sealed Flareless type
   e. Threaded coupling for Flared tubing

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Answer Sheet for Test
on
HYDRAULIC LINES AND FITTINGS

1. True

2. False

3. True

4. True

5. False

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910-XII8

Answer Sheet
for
AGRICULTURAL MACHINERY MECHANICS

UNIT: Hydraulics

TOPIC : Hydraulic Systems

1. a. Reservoir
   b. Pump
   c. Valve
   d. Motor (cylinder)

2. a. Blocked return line system
   b. Basic open center system
   c. Tandem open center system
   d. Through flow system
   e. Closed center system

3. a. (1) Reservoir
      (2) Pump
      (3) Ball valve
      (4) Pressure line
      (5) Cylinder

   b. (1) Cylinder
      (2) Return line
      (3) Ball valve
      (4) Reservoir

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Answer Sheet for Test
on
HYDRAULIC SYSTEMS

1. True

2. True

3. False

4. True

5. True

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910-I-1a

Topic Test
on
ORIENTATION

Student: ____________________ School: ____________________

Date: ____________________ Score: ____________________

Indicate by each statement True or False.

_______ 1. The number of farm workers during the past 30 years is down 44%, however, farm production is up 75%.

_______ 2. Wages paid by the farm machinery industry has been equal to wages paid to iron and steel workers.

_______ 3. Figures show that the increase cost of farm machinery has increased the cost of production.

_______ 4. The use of modern agricultural machinery has helped raise the farmers standard of living.

_______ 5. In areas where the farmers standard of living is high, the investment in agricultural machinery is also high.

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Topic Test
on
ORIENTATION

Student: ____________________ School: ____________________

Date: ____________________ Score: ____________________

1. What is the route taken in the distribution of agricultural machinery?

   ____.

2. What does the manufacturer do in addition to supplying the machinery needed? ____________________

   ____.

3. What is the function of the branch house? ____________________

   ____.

4. Into what 4 areas is the Local Dealership divided?

   a. ____________________

   b. ____________________

   c. ____________________

   d. ____________________

5. What 5 occupations are usually found in the service department?

   a. ____________________ c. ____________________

   b. ____________________ d. ____________________

   e. ____________________

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910-I-1c

Topic Test
on
ORIENTATION

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

The agricultural machinery dealership is usually divided into the following areas:

a. Management
b. Sales
c. Clerical
d. Parts
e. Service

Indicate in the blank by each of the following specific responsibilities the area in which they belong:

_____ 1. Determine company policies

_____ 2. Conducts demonstrations

_____ 3. Promotes sales

_____ 4. Makes general repairs

_____ 5. Writes contracts

_____ 6. Maintains catalogues and price lists

_____ 7. Pick-up and delivers new machinery

_____ 8. Appraises used machinery

_____ 9. Directs customer and employee relations

_____ 10. Handles field repairs

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910-I-2a

Topic Test
on
GENERAL SHOP SAFETY

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

Indicate before each statement whether it is true or false:

________ 1. The proper attitude is a most important consideration in safety.

________ 2. You must know what dangers are present to avoid accidents.

________ 3. WALK - avoid running is a good safety habit.

________ 4. Store sharp-edge tools in drawers to avoid cuts.

________ 5. If something gets in your eye, rub it very gently.

________ 6. The largest single cause of disability from all accidents is the improper handling of materials.

________ 7. Keep your back straight when lifting heavy objects.

________ 8. Over 60% of all injuries in the shop was caused by the misuse of hand tools according to a one year study.

________ 9. Light hammering on a wrench does not place excessive strain on it.

________ 10. It is best to use a file with a handle on the tang.

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Topic Test
on
SELECTING AND USING METALS AND LAYOUT TOOLS

Student: ____________________ School: ____________________

Date: ____________________ Score: ____________________

True or False:

T F

____ 1. All iron is made from iron ore, which is mined from the earth.

____ 2. Low carbon steels are more expensive to produce than high carbon steels.

____ 3. The heating and cooling process used to make cast iron into malleable iron is called annealing.

____ 4. The twelve inch blade of the combination square is most suitable for general work.

____ 5. The cross peen hammer is the most frequently used of the three types of peen hammers.

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910-I-4b

Topic Test
on
HAND TOOLS-CUTTING COLD METAL

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

Fill un the blanks:

1. Most hacksaw frames can be adjusted to fit blades of various__________.
2. The cold chisel must be ____________ than the metal it is to cut.
3. __________________ are made for cutting wrought iron and low carbon steel only.
4. When cutting____________stock, roll the metal and cut about one-third of the way through; then break the metal over the anvil.
5. When removing the nut from a rusty bolt, in most cases it is easier to ________ the nut.

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910-I-4c

Topic Test
on
HAND TOOLS-SHAPING STOCK AND FILING

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

Fill in the blanks:

1. Sharp corner bends ______________ the metal.
2. Files are made from high-carbon, specially ________________ steel.
3. Straight filing generally is used for ____________ work and sharpening.
4. When file teeth become clogged with metal chips, filing is __________.
5. The best way to clean a file is to rub the file ________ across the file.

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910-I-4d

Topic Test
on
HAND TOOLS-DRILLING

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

Fill in the blanks:

1. The ___ shaped vise is used for holding round stock.

2. Fractional size drills start at _____ of an inch in size.

3. The metal must be clamped tightly to the drill press table so that it will not __________ with the drill.

4. Size of twist drills are designated by numbers, _______________, or _______________.

5. A high-speed drill will cut _______________ metal than a carbon-steel drill will cut.

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910-I-4e

Topic Test
on
HAND TOOLS-TAPPING AND THREADING

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

List the following:

1. Two common types of bolt and nut threads:

   a. ______________________

   b. ______________________

2. Three types of taps:

   a. ______________________

   b. ______________________

   c. ______________________

3. Three common types of dies:

   a. ______________________

   b. ______________________

   c. ______________________

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Topic Test
on
THE PARTS OF MACHINES

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

Answer the following questions:

1. What is the function of bearings in farm equipment? ______________
____.

2. What factors determine the proper bearing to use?
   a. ______________________.
   b. ______________________.
   c. ______________________.
   d. ______________________.

3. Explain why proper lubrication is essential. ______________
____.

4. Of what may bushings be made?
   a. ______________________________.
   b. ______________________________.
   c. ______________________________.
   d. ______________________________.

5. Two types of bearing bushings are:
   a. ______________________.
   b. ______________________.

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Topic Test
on
FASTENING DEVICES

Student:________________ School:________________

Date:________________ Score:________________

PART I: Place in the blanks in the margin the number of the answer which you think makes a correct statement of the following:

1. ____ The pitch of a screw is (1) the number of threads on the screw; (2) the distance between threads; (3) the angle between thread faces; (4) the diameter of the threads; (5) none of these.

2. ____ Most of the new-type fasteners now on the market came from (1) the aircraft industry; (2) confiscated German patents; (3) the building trades; (4) the shipbuilding industry.

3. ____ To find the length of flat head wood screws, one measures (1) overall length; (2) from bottom of slot to point; (3) the shank; (4) none of these.

4. ____ A flat head cap screw 1/4 inch in diameter and 1 1/2 inches long with coarse series threads will usually be described:

   (1) 1/4" CAP SCREW 1 1/2 - 20NC - FLT. HD.
   (2) 1/4" x 1 1/2" - 20 NC - FLT. HD. CAP SCREW
   (3) 1/4" FLT. HD. CAP SCREW 1 1/2" - 20NC.

UNIT: Introduction
TOPIC: The Parts of Machines
(Topic Test continued)

PART III: Print + for TRUE or 0 for FALSE opposite the following statements:

1. _____ The distance across the flats of a standard bolt head determines its wrench size.

2. _____ Square headed bolts are used extensively in automobiles.

3. _____ All bolts and screws tighten by turning clockwise.

4. _____ The thread standards used in this country also apply to foreigh countries.

5. _____ Machine screws ordinarily have threads the entire length of the shank.

6. _____ Hanger bolts are used to fasten metal to metal.

PART IV: Fill in the blanks with a word or words to make, a true, complete sentence:

1. The new standard system governing the manufacture of fastening devices used in this country is called the ______________________________.

2. The length of bolts is measured from ________________ to ______________.

3. Thin washers with teeth around the inside or outside edges or both are called, ____________________.

4. A thin nut which is used with a thicker one to keep it from loosening on the bolt is called _________________________.

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910-I-

Topic Test
on
TRANSMISSION OF POWER

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

PART I: Answer the following questions:

1. List the six methods of transmitting power in farm equipment.
2. Explain how to properly fit a V-belt.
3. Determine the length of a V-belt using the following facts:

   Formula: $L = 2C + 1.57\,(D + d) + \frac{(D - d)^2}{4c}$

   $C = 2.4$ inches
   $D = 8$ inches
   $d = 4$ inches

4. Calculate the diameter of the pulley needed to turn a shaft 1800 Rpm's when the driven is a 6 inch pulley turning 2400 Rpm's.

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Topic Test
on
TRACTOR DESIGN

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

Answer the following questions:

1. What are the major types of tractors?
2. In what other way may tractors be classified?
3. Why is the all-purpose type tractor more widely used?
4. What are the three types of row crop wheel tractors?
5. What are the features of an orchard or grove tractor?

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Topic Test
on
THEORY OF OPERATION

Student:____________________ School:____________________

Date:____________________ Score:____________________

1. Explain briefly what happens during each stroke of a four cycle carburetor type engine. ____________________

____

____

____

____.

2. Explain briefly what happens during each stroke of a two cycle carburetor type engine. ____________________

____

____

____.

3. On what kind of machinery is a two cycle carburetor type engine used? ____________________

____.

4. How is a two cycle engine lubricated? ____________________

5. Explain the stroke of an engine. ____________________

____.

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910-II-2

Topic Test
on
ENGINE TYPES

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

1. What are the systems of an engine?
   a. ______________________
   b. ______________________
   c. ______________________
   d. ______________________

2. What are the principal engine parts?
   a. ______________________ f. ______________________
   b. ______________________ g. ______________________
   c. ______________________ h. ______________________
   d. ______________________ i. ______________________
   e. ______________________ j. ______________________
   k. ______________________

3. List 5 ways diesel and carburetor type engines differ:
   a. ______________________
   b. ______________________
   c. ______________________
   d. ______________________
   e. ______________________

UNIT: Internal Combustion Engines
TOPIC: Engine Types
(Topic Test continued)

4. Define:
   a. Bore - ________________________.
   b. Piston Stroke - ____.
   c. Piston displacement - ____.
   d. Fuel injection - ____________________________________.
   e. Crankshaft - ____.

5. What advantage is a sleeve type cylinder? ____.

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910-II-3

Topic Test
on
POWER MEASUREMENT

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

Answer the following questions:

1. Name three ways that tractor horsepower is measured.
   a. ______________________
   b. ______________________
   c. ______________________

2. Define btu. What is btu used for? ______________________
   ____.

3. Compare draw-bar horsepower and brake horsepower. ______________________
   ____.

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910-II-4

Topic Test
on
POWER PLANT CONSTRUCTION AND TERMINOLOGY

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

Gasoline engines are composed of many small parts. These parts are grouped into a number of systems or assemblies. List the seven groups or systems that have been studied and illustrated in this topic:

1. ____
2. ____
3. ____
4. ____
5. ____
6. ____
7. ____

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Topic Test
on
POWER PLANT DISASSEMBLE, ASSEMBLE AND REPAIR

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

1. Explain how to check the spark plug firing order. ______________

____

____

____

____

2. Which end of the push rod should be up when it is properly installed? ______________.

3. When installing head bolts what important factor should always be remembered? ______________________________.

4. All through the reassembling process there is one thing that should be done. This is to _____ the parts as they are installed.

5. On a diesel tractor what is the proper order of installation? _____

____

____

____

____

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Topic Test
on
LUBRICANTS (ENGINE OILS AND THEIR FUNCTIONS)

Student:____________________ School:____________________

Date:____________________ Score:____________________

PART I: Place a check under T for true or F for false in each of the following statements:

T	F	
____	____	1. Viscosity increases as the oil is heated.
____	____	2. Oxidation results from cold engine operation.
____	____	3. For periods of short operation, light load, rich mixtures or excessive idling; a detergent-dispersant oil should be used.
____	____	4. Oil additives are used up as the engine operates.
____	____	5. Viscosity refers to the thickness of the oil.

PART II: Fill in the blanks:

1. Main bearings, rod bearings, wrist pins and pistons depend almost entirely upon the circulation of oil for ________________.

2. ________________ is the most important characteristic of an oil if it is to seal properly.

3. Three reasons why it is advisable to change oil regularly are: 1. ________________________________, 2. ________________________________,
3. ____.

4. In gasoline or diesel engines the thickening effect of oil is not apparent because of the ______________ effect of the ______________.

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910-III-1b

Topic Test
on
LUBRICANTS: CRANKCASE-OIL VISCOSITY (GRADE)AND CRANKCASE-OIL TYPE (SERVICE CLASSIFICATION

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

PART I: Underline the most appropriate answer:

1. The type of oil not recommended by any farm tractor manufacturer for crankcase oil is (1) MS, (2) DS, (3) ML, (4) MM.

2. The results which may be expected from using a SAE grade that is too heavy is (1) hard cold weather starting, (2) extra power required for oil circulation, (3) poor lubrication of tight fitting bearings, (4) all of these.

3. A substance which prevents deposits of oil contaminants by holding them in suspension is called (1) viscosity, (2) oxidation, (3) dilution, (4) detergent-dispersants.

4. A higher SAE grade number indicates that the oil is (1) more fluid, (2) less fluid, or (3) has no effect as fluid.

5. The only way to be sure that you are using the proper oil in crankcase is to (1) use a multiple grade oil, (2) ask your neighbor what he used, (3) ask your dealer what to use, (4) look it up in the operator's manual.

PART II: Complete the following:

1. The __________ viscosity grade number indicates that the oil is more fluid.

2. What do the following letters mean?
   a. ML
   b. MM
   c. MS
   d. DG
   e. DM
   f. DS

UNIT: Lubricants and Lubricating Systems
TOPIC; Lubricants: Crankcase-Oil Viscosity (Grade) and
Crankcase-Oil Type (Service Classification)
(Topic Test continued)

3. The letters API mean ____________________ ____________________ ______________.

4. A multiple grade oil may replace _____ grades of single grade oil.

5. What happens to oil viscosity when it is heated?

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910-III-1c

Topic Test
on
LUBRICATION: GEAR OILS, HYDRAULIC OILS AND LUBRICATING GREASES

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

PART I: Fill in the blanks:

1. SAE 75, SAE 80, SAE 90, SAE 140, SAE 250 are numbers used for ______________________.

2. Transmission and differentials may use ________________ or ______________________.

3. Hydraulic oil may be used in a tractor for operating the hydraulic ________________ or ________________.

4. ______________________ grease is recommended for jobs which require a lubricating grease.

5. ______________________ and ______________________ are two common additives used in lubricating grease.

PART II: True or False:

________ 1. Crankcase oils are sometimes recommended by manufacturers to be used in hydraulic systems.

________ 2. Multi-purpose grease is recommended for most jobs which require a lubricating grease.

________ 3. LPG is a type of crankcase oil which is not recommended for tractors.

________ 4. Tractor manufacturers sometimes provide a special oil that is different from those available under API Classifications.

________ 5. There are three kinds of oils that may be used in hydraulic systems.

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Topic Test
on
LUBRICATING SYSTEMS

Student: ____________________ School: ____________________

Date: ____________________ Score: ____________________

PART I: True or False:

_______ 1. All engines have oil filters.

_______ 2. All oil must pass through the filter system.

_______ 3. A breather is not necessary on an enclosed crankcase engine.

_______ 4. There are two general classifications of engine lubricating systems.

_______ 5. A good lubricating system is always complicated.

PART II: Fill in the following blanks:

1. Two types of oil indicators are __________ and __________.

2. The most used type oil pump is the _______ pump.

3. Engine oil systems are classified into three major groups. These are:

   a. ____________________

   b. ____________________

   c. ____________________

4. Oil filters may be filled with ____________________, ____________________ or ____________________.

5. In order to maintain the correct pressureand control the quantity of oil circulated in an engine a ____________________ is used.

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910-IV-1

Topic Test
on
FUELS AND PRINCIPALS OF COMBUSTION

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

Answer the following questions:

1. Name the four common liquid fuels:

   a. ______________________

   b. ______________________

   c. ______________________

   d. ______________________

2. What are the two chief impurities in gasoline that may cause trouble?

   a. ______________________

   b. ______________________

3. What is the range of fuel to air mixtures on which an engine will operate? ______________________

4. Often times it is necessary to lower the fuel to air ratio to ___ : ___ in order to start the engine in extremely cold weather.

5. What is the ideal ratio of fuel to air for an engine to operate with greatest efficiency and horsepower? __:__.

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Topic Test
on
GASOLINE SYSTEMS

Student: ____________________ School: ____________________

Date: ____________________ Score: ____________________

Answer the following questions:

1. Explain what is meant by updraft and downdraft systems. ____________________

____________________.

2. What is a venturi? ____________________.

3. What are the four systems of a carburetor?

   a. ____________________

   b. ____________________

   c. ____________________

   d. ____________________

4. Explain how to properly set the idle valve in a carburetor. ____________________

____

____________________.

5. What are three reasons for servicing and maintaining the manifold heat control?

   a. ____________________

   b. ____________________

   c. ____________________

910-IV-3

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Topic Test
on
L. P. GAS SYSTEM

Student: ____________________ School: ____________________

Date: ____________________ Score: ____________________

Place a T by the correct statements and F by the false:

_____ 1. In all cases LP gas is cheaper to operate.

_____ 2. Butane will "freeze" before propane.

_____ 3. Gasoline has a higher btu rating than LP gas.

_____ 4. LP gas leaves a carbon build up in engines.

_____ 5. Butane has a greater btu rating per gallon than propane.

_____ 6. LP gas is stored in a gaseous form.

_____ 7. Gasoline and LP carburetors are very similar.

_____ 8. LP gases are heavier than air.

_____ 9. LP gases have a high octane rating.

_____ 10. The boiling point of LP fuels is below the freezing point of water.

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910-IV-4

Topic Test
on
GOVERNORS

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

Place a T by the true statement and F by the false statement.

_____ 1. The vane-type governor can be used on tractors.

_____ 2. The fly ball governor depends upon centrifugal force for its operation.

_____ 3. An engine with no speed control mechanism would continue to increase in speed until it would fly apart.

_____ 4. The most common way to control the speed of an engine is to regulate its fuel intake.

_____ 5. LP gas engines require a different type governor than a gasoline engine.

_____ 6. Governors will function only at higher engine speeds.

_____ 7. The fly ball type governor requires special lubrication.

_____ 8. The driver of a vehicle by adjustment of a hand lever may control the governors speed.

_____ 9. The parts of a governor are: a shaft, weights, springs and sliding collar.

_____ 10. The only purpose of a governor is to regulate engine speed to insure constant belt speed.

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910-IV-5a

Topic Test
on
DIESEL FUEL SYSTEMS-PRINCIPLES OF OPERATION, COMBUSTION CHAMBER, AIR SYSTEMS AND STARTING AIDS

Student: ____________________ School: ____________________

Date: ____________________ Score: ____________________

Answer the following questions:

1. What is the range of compression ratios of a diesel engine? __________ __________.

2. What is the temperature range of the compressed air in diesel engines? __________.

3. Is it anymore important to keep a diesel fuel system clean than it is to keep a gasoline system clean? _____ Explain. ____________________ ____________________ ____________________.

4. Do all diesel engines require a special forced air system for operation? _____.

5. What do diesel engines depend upon to ignite the fuel? ______________ ____________________.

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Topic Test
on
DIESEL FUEL SYSTEMS, INJECTION PUMP AND FUEL INJECTORS

Place a T by the true statements and an F by the false statements:

____ 1. The injection pump may develop as much as 20,000 psi pressure in diesel fuel system.

____ 2. If two or more filters are used, the second filter will not require attention as often as the first.

____ 3. Some tractors have special gages connected to the fuel line which show when filters need to be changed.

____ 4. If the injection pump consists of both pump and injector nozzle, there is no high pressure line.

____ 5. On engines having no high pressure line each cylinder will have three rocker arms.

____ 6. All diesel engines have a return fuel line for excess fuel to return to the storage tank.

____ 7. The fuel filters are always located on the high pressure line.

____ 8. The injection pump is responsible for timing the fuel injection, acting somewhat like a distributor on a spark-ignited engine.

____ 9. When changing the filter elements, it is not always necessary to turn off the fuel supply.

____10. If air enters the fuel system, it will automatically bleed back through the system into the fuel system.

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Topic Test
on
AIR CLEANERS

Student: ______________________________ School: ______________________________

Date: ______________________________ Score: ______________________________

Answer the following questions:

1. Why is it important to use air cleaners on farm engines? ______________
____
____.

2. Why is gasoline not recommended for cleaning air cleaners? __________
______________________________.

3. Does the use of a good air cleaner always mean that no dust will enter the engine? ______ Explain. ____
____

4. How will the use of an air cleaner effect the service life of an engine?
____.

5. Why is it important to refer to the operator's manual for information on servicing air cleaners? ____
____.

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910-IV-7

Topic Test
on
INTAKE AND EXHAUST MANIFOLDS AND PIPES

Student: ____________________ School: ____________________

Date: ____________________ Score: ____________________

Answer the following questions:

1. Explain the function of the intake manifold. ____________________
____.

2. Define inertia as related to the intake manifold. ____________________
____.

3. What effect will back pressure have upon an engine? ____________________
____.

4. Explain why gaskets are necessary in the manifold system and what kind is used. ____________________
____
____.

5. What is the relationship of the exhaust manifold to the intake manifold?
____
____.

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910-V-1

Topic Test
on
LIQUID AND AIR COOLING SYSTEMS

Student: ____________________ School: ____________________

Date: ____________________ Score: ____________________

1. What are the two main types of cooling systems? ______________ and ______________.

2. What are the two main types of liquid systems? ______________

   and ______________.

3. When a cooling system is operating in-effectively, what results may a person expect from the engine that is running either too hot or too cold?

   a. ______________

   b. ______________

   c. ______________

   d. ______________

   e. ______________

4. What are the normal operating temperatures of diesel, gasoline, and tractor fuel engines?
   Diesel ________

   Gasoline ________

   Tractor ________

5. Where should the thermostat be placed in a liquid cooled engine? ______

   ____.

UNIT: Cooling Systems
TOPIC: Liquid and Air Cooling Systems
(Topic Test continued)

6. Explain how air alone can cool an engine.

7. What is the advantage of a pressure system?

8. What effect will excessive belt tension have on the cooling system?

9. How often should the cooling system of a farm tractor be flushed?

10. How can a thermostat be tested for accuracy?

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910-VI-1

Topic Test
on
MAGNETO SYSTEMS

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

Place a T by the true statements and an F by the false statements:

____ 1. Magneto systems require little attention.

____ 2. Magneto systems are completely different to the battery system.

____ 3. All tractor magnetos use a novel device to five the armature or rotor a quick flip when cranking.

____ 4. When changing points on a magneto system, the condenser should also be replaced.

____ 5. Magneto points can be filed or honed to recondition them.

____ 6. Keeping the magneto clean and the points properly adjusted are two items essential to proper functioning of this unit.

____ 7. The magneto has some of the most finely finished and closely fitted bearings in the tractor.

____ 8. Points are always in need or repair after 200-300 hours of operation.

____ 9. The impulse coupling will only operate under 300 RPM.

____ 10. A magneto system has a coil, breaker points, condenser, distributor, rotor, wires, and spark plugs.

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Topic Test
on
BATTERY IGNITION SYSTEMS

Student: ____________________ School: ____________________

Date: ____________________ Score: ____________________

Answer the following questions:

1. What length of time is required for the primary and secondary circuits to function? ____________.

2. Name the principal circuits in a battery ignition system?
   a. ____________________
   b. ____________________
   c. ____________________
   d. ____________________

3. If a four cycle engine turning at 1800 RPM requires 60 sparks per second, calculate the following:
   a. How many sparks are required per minute? __________
   b. How many sparks are required per minute per cylinder? __________
   c. How many aparks would be required for a 6 cylinder engine @ 1800 RPM per minute? __________
   d. How many sparks would be required for 1 hour for a cylinder engine running at 1800 RPM? __________

4. What is the advantage of a 12 volt electrical system? ____________________.

5. What does the electric ignition system depend upon to do its work? ____ ____________________.

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Topic Test
on
THE BATTERY

Student: ____________________ School: ____________________

Date: ____________________ Score: ____________________

Place T by the true statements and F by the false statements:

____ 1. A light grease film will aid in keeping battery terminals free from corrosion.

____ 2. Battery cells are connected in series in order to combine to make up the total voltage of the battery.

____ 3. A battery is so designed that they will operate under rough field conditions with no harm.

____ 4. The best way to be sure that the terminals are on tight is to tap them with a hammer.

____ 5. The hydrometer tells us the voltage of each cell so that we can tell the state of charge of the battery.

____ 6. The electrolyte level should be at least 3/8" above the plates.

____ 7. Poor battery connections will not effect the operation of the vehicle.

____ 8. Plate separators may be made of wood, rubber, or glass fibers.

____ 9. If a battery has a specific gravity reading of 1. 130 or below, it is discharged.

____ 10. A battery having a specific gravity reading of 1. 280 will withstand greezing weather down to -90° F.

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Topic Test
on
GENERATORS, ALTERNATORS AND ACCESSORIES

Student: ____________________ School: ____________________

Date: ____________________ Score: ____________________

Answer the following questions and fill in the blanks:

1. To clean the commutator, what one of two items should be used?
____.

2. When a battery has been replaced, it is necessary to do what to the generator? ____________________.

3. What are 3 methods used to regulate current flow to the battery?
a. ________________

b. ________________

c. ________________

4. If the strap of a generator has lead deposits on it, what does this indicate? ____.

5. The alternator current must be changed into ________ current before it can be used by the battery. This is done in the alternator by ________.

6. What is the job of the generator? ____________________________

____.

7. What is a simple test to tell if a generator is burned out? ____________

____.

8. What is the purpose of the brushed in a generator? __________________

________________________.

UNIT: Electrical System
TOPIC: Generators, Alternators, and Accessories
(Topic Test continued)

9. What is the "watchdog" of the electrical system?________________________.

10. When setting the third brush of a three brush system, what should always be kept in mind concerning the brush settings?______________________________
____

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910-VI-5

Topic Test
on
STARTERS

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

Complete the following statements:

1. A starting motor draws __________ current.
2. The bendix pinion engages the ____________________ to start the engine.
3. The starting motor is a small but powerful ________________________ motor.
4. The bendix pinion disengages when ______________________________.
5. The commutator may be cleaned by ______________________________.
6. The starter is wound with heavy wire so it can withstand the heavy draw of currect without _____________.
7. Some starters use an electric _____________ to engage the starting gear.
8. It is necessary to keep all wires ____________ and __________ to receive best service from your starter.

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910-VII-1

Topic Test
on
TIMING THE IGNITION SYSTEM

Student: ____________________ School: ____________________

Date: ____________________ Score: ____________________

Place a T in front of the true statements and an F in front of the false statements.

_______ 1. The breaker point method of timing is as accurate as timing by a light.

_______ 2. The spark should occur at the time the piston reaches TDC or just slightly before.

_______ 3. Power is lost, engine temperature increases, and efficiency is lowered by incorrect timing.

_______ 4. Installation of new points should not effect the engine timing.

_______ 5. An ignition system will not spark unless the engine is running.

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910-VII-2

Topic Test
on
VALVE CLEARANCE ADJUSTMENTS

Student: ______________________________ School: ______________________________

Date: ______________________________ Score: ______________________________

Complete the following statements:

1. Two kinds of valves are ____________ and ____________.

2. Adjustments are made between the ________________ and ________________.

3. Valve condition and operation are most important to engine ______________.

4. Two other names under which valve clearance adjustments may be known are ____________________ and ____________________.

5. Always check the ____________________ for proper valve adjustment information.

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910-XII-1

Topic Test
on
INTRODUCTION

Student: ____________________ School: ____________________

Date: ____________________ Score: ____________________

Answer the following questions:

1. What are the basic parts of a hydraulic system?

2. Hydraulic theory is based on Pascal's law. What is the law?

3. Give a simple definition of hydraulics.

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910-XII-2

Topic Test
on
RESERVOIRS

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

Place a T in front of the true statements and F in front of the false statements.

_______ 1. On most farm and industrial equipment applications, the reservoir is a built-in-unit.

_______ 2. The size of the reservoir depends on the locality, and where the system is to be used.

_______ 3. An ideal size is the capacity per minute of the pump.

_______ 4. The dipstick shows the proper level of fluid.

_______ 5. The reservoir should be free of dirt, moisture, and other contaiminating materials at all times.

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910-XII-3

Topic Test
on
HYDRAULIC PUMPS

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

Place a T in front of the true statements and F in front of the false statements.

_______ 1. The pump is the power supply of the hydraulic system.

_______ 2. External gear pumps are of the constant delivery type.

_______ 3. External gear pumps are used principally where relatively low pressures, volumes, economy of cost, and restricted space are factors.

_______ 4. Vane pumps cannot handle a large volume of fluid at high pressure.

_______ 5. Radial pumps are compact and rugged.

_______ 6. Centrifugal pumps deliver a pulsating flow of fluid.

_______ 7. Multi-stage pumps are used to provide fluid at more than one pressure.

_______ 8. Clearances are extremely critical in hydraulic pumps.

_______ 9. Hydraulic pumps can be thought of as compressors.

_______ 10. Pumps with reciprocating piston are useful in extremely high pressure application.

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910-XII-4

Topic Test
on
HYDRAULIC VALVES

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

Place a T in front of the true statements and F in front of the false statements.

_______ 1. Nearly all the valves used in hydraulic systems may be classified in three categories: Directional, Volumes, or Pressure.

_______ 2. Until "variable delivery" pumps were put on the market, valves were the only means of controlling fluids in a hydraulic system.

_______ 3. Control of valves is either manual or electrical.

_______ 4. Globe valves offer some restriction to flow, and may cause turbulence in the fluid.

_______ 5. Gate valves offer no resistance to flow.

_______ 6. Flapper valves are essentially check valves in that they permit flow in only one direction.

_______ 7. Ball valves permit flow in either direction.

_______ 8. Needle valves are usually manually operated.

_______ 9. Spool valves are very popular in hydraulic equipment because of quick, positive action.

_______ 10. There are two basic types of spool valves; the open center and the closed center.

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910-XII-5

Topic Test
on
HYDRAULIC CYLINDERS

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

Place a T in fron of the true statements and F in front of the false statements.

________ 1. The double acting cylinder is called a differential type cylinder.

________ 2. The "stepped piston" provides a means for a rapid approach stroke at low pressure and a slower, more powerful work stroke.

________ 3. An important refinement of the hydraulic cylinder provides a "cushion" for the end of the stroke of the piston.

________ 4. Cylinders may be classified into two general categories; single action and double action.

________ 5. The hydraulic cylinder is by far the most popular method of turning fluid under pressure into a work force.

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Texas Education Agency
Texas A&M University
(cooperating)

Topic Test
on
HYDRAULIC SEALS AND PACKINGS

Student: ____________________ **School:** ____________________

Date: ____________________ **Score:** ____________________

1. Identify the different types of seals and packings in the illustration that follows: Write the names in the blanks that correspond to the letters below:

a. ____________________ f. ____________________

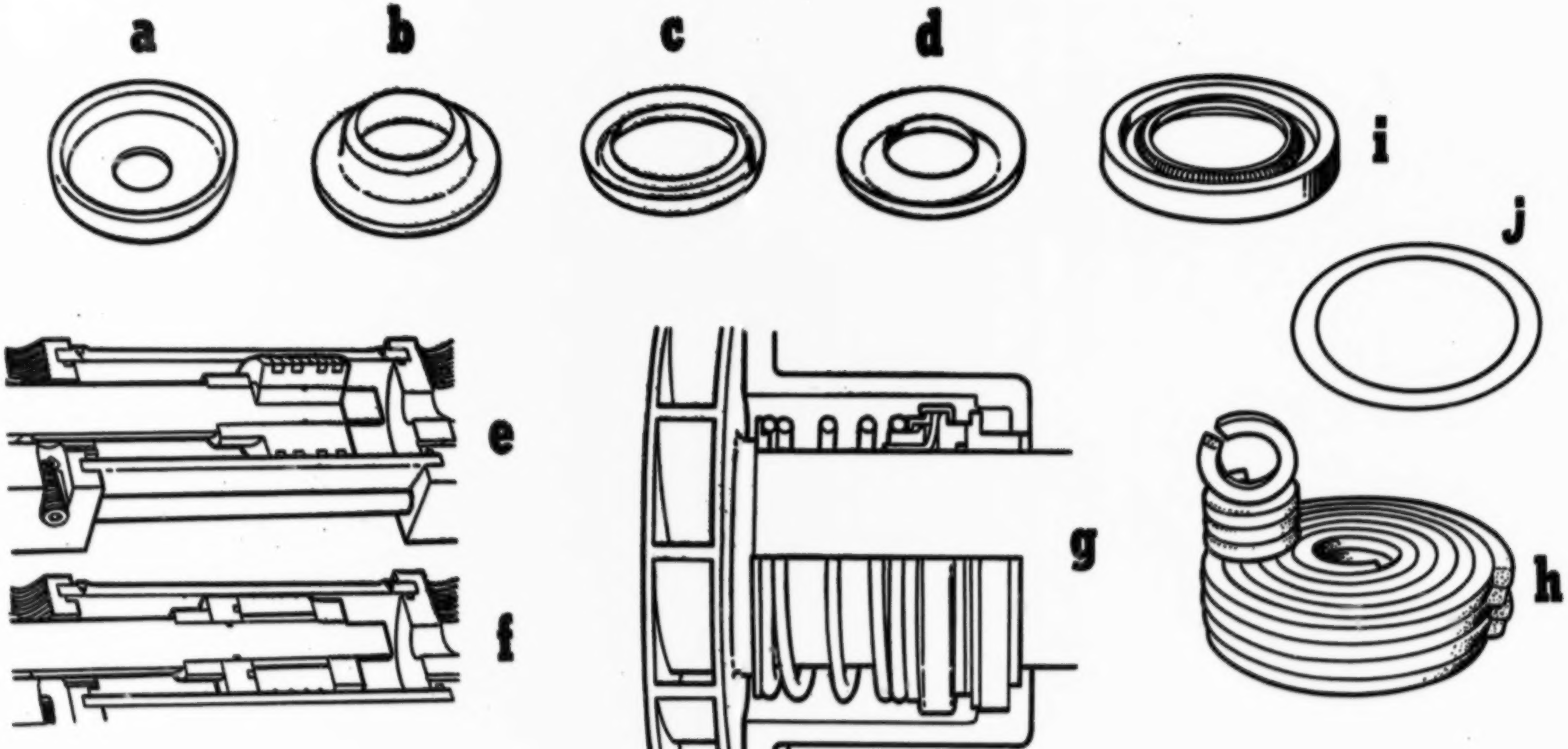
b. ____________________ g. ____________________

c. ____________________ h. ____________________

d. ____________________ i. ____________________

e. ____________________ j. ____________________

SEALS AND PACKING


a
b
c
d
i
j
e
f
g
h

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Topic Test
on
HYDRAULIC LINES AND FITTINGS

Student: ______________________ School: ______________________

Date: ______________________ Score: ______________________

Place a T in front of the true statements and an F in front of the false statements:

____ 1. In a hydraulic system piping is usually measured according to its inside diameter.

____ 2. Galvanized pipe is highly recommended for use in hydraulic systems.

____ 3. In piping and tubing the bending radius is ideally not less than three times the I. D. of the tube.

____ 4. Due to the possibility of leakage, threaded connections are avoided as much as possible.

____ 5. Flange fittings cannot be welded to the pipe ends.

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Topic Test
on
HYDRAULIC SYSTEMS

Student: ____________________ School: ____________________

Date: ____________________ Score: ____________________

OPEN BOOK TEST

Place a T in front of the true statements and an F in front of the false statements:

____ 1. The blocked return line system uses a lever operated check valve, and will operate a single acting cylinder only.

____ 2. The tandem open center system uses a center spool type valve.

____ 3. Three components are necessary to have a workable hydraulic system--a reservoir, a valve, and a cylinder.

____ 4. A ball valve is used in the block return line system.

____ 5. The basic open center system has a double action cylinder.